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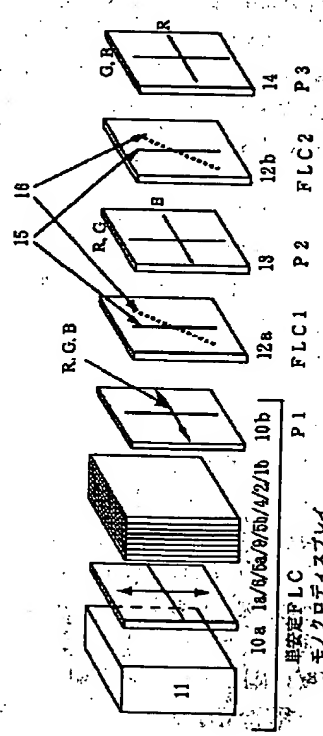
(54)【発明の名称】　液晶装置及びその駆動方法

(57)【要約】

【構成】　単安定強誘電性液晶素子（単安定ＦＬＣ素子）と、この液晶素子を駆動するＴＦＴ等のアクティブマトリックス素子と、フィルタ素子とを組み合わせた液晶表示デバイス。

【効果】　広視野角で高速応答性があり、階調表示を可能にし、更には、解像度も向上させ得る液晶装置（特にフルカラー表示装置）とその駆動方法を提供することができる。



色順次駆動単安定ＦＬＣ表示デバイスの構成

【特許請求の範囲】

【請求項１】　単安定強誘電性液晶素子と、この液晶素子を駆動するアクティブマトリックス素子と、フィルタ素子とを組み合わせた液晶装置。

【請求項２】　単安定強誘電性液晶素子が１msec以下の応答時間を有し、フィルタ素子が１msec以下で色順次に切り替え可能である、請求項１に記載した装置。

【請求項３】　単安定強誘電性液晶素子とアクティブマトリックス素子とを組み合わせてモノクロの表示素子が構成され、この表示素子と表示観測位置との間にフィルタ素子が配置されている、請求項１又は２に記載した装置。

【請求項４】　単安定強誘電性液晶素子とアクティブマトリックス素子とカラーフィルタ素子とを組み合わせてカラーの表示素子として構成されている、請求項１又は２に記載した装置。

【請求項５】　請求項１～４のいずれか１項に記載した液晶装置を駆動するに際し、アクティブマトリックス素子によって単安定強誘電性液晶素子を駆動し、この駆動と同期してフィルタ素子を切り替える、液晶装置の駆動方法。

【請求項６】　単安定強誘電性液晶素子の駆動を１msec以下の応答時間で行い、フィルタ素子の切り替えも１msec以下で行う、請求項５に記載した方法。

【請求項７】　単安定強誘電性液晶素子に対する情報書き込み過程においてフィルタ素子を黒の状態にする、請求項５又は６に記載した方法。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は液晶装置（例えば透明電極及び配向膜をこの順に設けた一対の基板が所定の間隙を置いて対向配置され、前記間隙内に強誘電性液晶が配されている強誘電性液晶素子を用いた表示装置）及びその駆動方法に関するものである。

【０００２】

【従来技術】液晶表示素子は、薄型で低消費電力で駆動が可能であるという利点から、フラットパネルディスプレイとしての需要が伸びてきている。特に、アクティブマトリックス駆動のツイストネマチック液晶表示素子（ＴＮ－ＬＣＤ）では、その画質が近年飛躍的に向上している。

【０００３】しかしながら、ディスプレイの大画面化に伴い、ＴＮ液晶が分子配向のねじれを持っているために、視野角の狭さ、階調の反転、更には、応答速度が遅いために生じる尾引き等の残像が問題となっている。

【０００４】視野角の拡大に関しては、位相補償フィルムの採用、配向膜の工夫によるツイスト構造のキャンセル等の手法が開発されつつあるが、まだ不十分である。また、応答速度に関しては、現在のＴＦＴ（薄膜トランジスタ）の駆動電圧ではもちろん、駆動電圧を高くしても、電解除去時のツイスト構造への復帰の応答時間は数十ミリ秒以下に短縮することはできないため、例えば、ノーマリーホワイトの表示素子では黒から白への応答が極めて遅く、特に尾引き等の残像が目立つ結果となる。

【０００５】この広視野角、高速応答を同時に実現する液晶材料としては、強誘電性液晶（ferroelectric liquidcrystals（ＦＬＣｓ））が考えられる。表面安定型強誘電性液晶表示素子（ＳＳＦＬＣＤ）は、ＴＮ液晶の約1000倍の高速応答性とメモリ性により、パッシブマトリックス駆動で1000本以上の走査線数、広視野角で安価な大画面フラットパネルディスプレイを実現する技術として期待され、検討されている。

【０００６】こうした強誘電性液晶（更には、反強誘電性液晶の液晶）では、電解印加による液晶ダイレクタのスイッチング挙動は液晶辞典ｐ150(培風館）に記載されている南部－ゴールドストーンモードに従って液晶分子が仮想的なコーン上を動き、更に、電傾効果を有するスメクチックＡ液晶（液晶辞典ｐ145(培風館））では、液晶辞典ｐ119(培風館）に記載されているソフトモードを利用した場合でも、コーン角に類似した各液晶組成物に固有のコーン角を有している。

【０００７】即ち、図23に示すような電極間に挟まれた液晶のコーンモデルを考える。コーンの開き角をコーン角θｒと呼び、このコーン角の透明電極の付いたガラス基板への投影を見かけのコーン角θａと呼ぶ。光学的にはこの見かけのコーン角θａについて考えれば良い。ここで、コーン角の測定については、２つのスイッチ状態における液晶ダイレクタのなす角を測定するものであり、具体的には液晶セルを偏光子が直交した偏光顕微鏡下で、消光位（回転して暗くなる位置）でのステージの回転角から求めた。

【０００８】しかしながら、従来のＦＬＣ、特にＳＳＦＬＣＤでは、ＦＬＣ分子の永久双極子と電界との強い相互作用のために高速応答性を示すが、図23に示したように、液晶分子が配向膜分子からの束縛により双安定化される。

【０００９】従って、この等エネルギーの２状態間でのスイッチングでは、電圧印加に対する急峻な閾値特性のために傾き角θａを連続的に制御することができず、階調表示が困難であった。

【００１０】ＳＳＦＬＣＤのパッシブ駆動での階調表示法としては、タイムインテグレーション法や一つの画を分割した面積階調法等、デジタル的な方法が提案されている。しかし、このデジタル法では、まだ十分な階調数を得るには至っていない。

【００１１】一方、最近になって、ＴＮ液晶素子において用いているアクティブマトリックス素子とＦＬＣとを組み合わせることにより、双安定メモリ性を用いない階調表示法も提案されている。

【００１２】例えば、カイラルスメクチックＣ相でのピ

ッチ長が光学波長よりも短いＦＬＣを用いて、そのねじれたヘリックス構造を電界印加により解き、液晶ダイレクタの平均的傾きを制御することにより、階調制御するものである。しかしながら、液晶配向が縞状の組織構造を有するために、そのコントラストは低い。

【００１３】

【発明が解決しようとする課題】本発明の目的は、広視野角で高速応答性があり、階調表示を可能にし、更には解像度も向上させ得る液晶装置（特にフルカラー表示装置）とその駆動方法を提供することにある。

【００１４】

【課題を解決するための手段】即ち、本発明は、単安定強誘電性液晶素子（単安定ＦＬＣ素子）と、この液晶素子を駆動するＴＦＴ等のアクティブマトリックス素子と、フィルタ素子とを組み合わせた液晶装置（ＬＣＤ）に係るものである。

【００１５】本発明の液晶装置によれば、液晶素子として単安定ＦＬＣ素子を用いているので、後述することから明らかなように、ＴＮ素子では不可能であった、広視野角で１msec以下の高速応答性の表示を階調性良く実現することができる。このような広視野角、高速応答性の単安定ＦＬＣ素子をＴＦＴ等のアクティブマトリックス素子で駆動し、フィルタ素子（特に１msec以下で色順次に切り替え可能なカラーフィルタ等のフィルタ素子）によって、対応する色の表示を再現性良く高階調度に得ることができる。

【００１６】本発明の液晶装置のように、ＦＬＣをＴＦＴ等のアクティブマトリックスで駆動し、階調性を発現させるためには、少なくとも２つの駆動条件が必要となる。即ち、（１）各画素に１フィールド間に印加され続ける電圧の強度により階調性が制御されること、（２）液晶に電荷が蓄積されないようにフィールド間或いはフレーム間で印加電圧を反転した駆動方法が適用できることである。

【００１７】これらの（１）、（２）の駆動条件を実現するには、印加電界強度に対して液晶分子の傾き角がほぼリニアに変化し、極性反転により等価な傾き角を有することが重要である。

【００１８】その実現のために、本発明者は、図13に示すように、液晶分子と配向膜界面との相互作用を強め、仮想的なコーンの下側の一つの状態で液晶分子を安定化させれば、電界と液晶分子の自発分極との直接的相互作用により発生するトルクと液晶ダイレクタのＳplay変形（広がり変形）に伴う弾性との釣合いにより、液晶分子の傾き角θａを印加電圧により連続的に制御でき、更に、この構造を実現すれば、液晶のモノドメイン化も容易であると考えた。

【００１９】そこで、本発明者は、光学波長よりもピッチの長いＦＬＣ組成物を調製し、更に配向規制力が大きいと予想される低プレチルトの配向膜材料と組み合わせることにより、液晶分子配向が配向処理方向に配列し、安定化した単安定ＦＬＣモードをモノドメインで実現できることを見出した。

【００２０】このような単安定ＦＬＣモードは、電界を印加しないとき分子の配列方向が配向処理方向に安定化し、電界印加により、その極性に応じて左右にその分子の配列方向が傾く。この傾き角は電界強度により制御できるので、ＴＦＴによる電圧制御によりアナログ階調が可能である。また、モノドメイン化により暗レベルを下げ、高コントラスト比を得ることができる。

【００２１】更に、この単安定ＦＬＣを例えば 0.7インチ、10.3万画素のＴＦＴ素子と組み合わせることにより、ＦＬＣ表示素子の特徴である広視野角、高速応答性を生かし、大画面化に伴ってＴＮ液晶で問題となっている視野角特性、中間階調の応答性を向上させたカラーディスプレイを実現することができる。

【００２２】本発明の液晶表示装置においては、単安定ＦＬＣ素子（特に１msec以下の応答速度を有する単安定ＦＬＣ素子）とアクティブマトリックス素子とを組み合わせてモノクロの表示素子が構成され、この表示素子と表示観測位置（例えば観測者）との間にフィルタ素子（特に１msec以下で色順に次切り替え可能なもの）が配置されているのがよい。

【００２３】即ち、アクティブマトリックスのＴＮ液晶表示素子において、カラーフィルタを配置したものでは、Ｒ（赤）、Ｇ（緑）、Ｂ（青）の３つの画素の組で一つの画素となるため、その表示素子の解像度を低下させていた。しかし、上記のように表示素子をモノクロとし、フィルタ素子を色順次に切り替えるようにすると、一つの画素でＲ、Ｇ、Ｂを兼用でき、その分だけ画素密度を高め、高解像度（例えば従来の３倍）を実現できる。

【００２４】勿論、単安定ＦＬＣ素子とアクティブマトリックス素子とカラーフィルタ素子とを組み合わせてカラーの表示素子として構成されてもよい。

【００２５】本発明はまた、上記した本発明の液晶装置を駆動するに際し、アクティブマトリックス素子によって単安定ＦＬＣ素子を駆動し、この駆動と同期してフィルタ素子を切り替える、液晶装置の駆動方法も提供するものである。

【００２６】この駆動方法においては、単安定ＦＬＣ素子の駆動を１msec以下の応答時間で行い、フィルタ素子の切り替えも１msec以下で行うことができる。

【００２７】また、単安定ＦＬＣ素子に対する情報書き込み過程（特に異なる色表示の間）においてフィルタ素子を黒の状態にすると、色の切り替え時に色残りをなくし、色の純度バランス（画質の品位）を向上させることができる。

【００２８】

【実施例】以下、本発明を実施例について更に詳細に説

明する。

【００２９】単安定強誘電性液晶（単安定ＦＬＣ）とその特性

まず、本発明に使用可能な単安定ＦＬＣとその特性について説明する。

【００３０】１．液晶材料

単安定ＦＬＣモードの基本動作を確認するため、強誘電性液晶として、高速応答性付与のためにカイラル部にフッ素を導入した自発分極の大きな図14に示す如き強誘電＊

＊性液晶を新規に合成し、そのカイラル分子を、室温でスメクチックＣ相を示すホスト液晶に添加したＦＬＣ組成物を調製した。

【００３１】ホスト液晶としてはSplay弾性率（広がりの弾性定数）が高く、液晶層傾斜角δとコーン角θを等しくなるようにブレンドしたフェニルピリミジン系液晶を用いた。下記の表１に、ＦＬＣ組成物の代表的な物性値を示す。

【００３２】

表１（ＦＬＣ組成物の物性）

ＦＬＣ組成物	ピッチ長（μｍ）	自発分極値（nC/cm²）
ＦＬＣ１	２．５	１１．５
ＦＬＣ２	２１．２	２．５
ＦＬＣ３	１０．０	１６．０

【００３３】これらのＦＬＣ組成物はいずれも、室温でカイラルスメクチックＣ相を有し、数%のカイラル液晶の添加で自発分極値は２～12nC/cm²を示した（ＦＬＣ１、ＦＬＣ２）。一般的には、自発分極値Ｐｓが大きい方が高速化されるが、応答時間τは粘性係数ηと印加電界強度Ｅを用いて

$\tau \propto \eta / (Ps \cdot E)$

で表されるため、粘性にも影響される。

【００３４】一方、ＳｍＣ＊相でのヘリカルピッチ長は光学波長よりも長く、狭ギャップセル中では、配向膜との相互作用により螺旋が解けるため、一様な液晶配向を達成できる。

【００３５】更に、実用的な液晶材料として、高速化、広い動作温度を実現した材料（ＦＬＣ３）を選択した。

【００３６】２．配向膜材料とセルの作製

配向膜材料は、ＦＬＣ組成物との相互作用が強く、低プレチルト角を与えるポリイミド系配向膜材料の中から良配向を与えるものを選択した。具体的には、宇部興産社製Ｕ－ワニス等を用いた。

【００３７】ホモジニアス配向セルの作製は、ガラス基板上の透明電極にポリイミド配向膜を形成し、ラビング処理方向の組み合わせかたにより、平行セル、反平行セルを作製した。

【００３８】３．単安定評価用の波形

単安定ＦＬＣ評価用の駆動波形を図15に示す。波形は、印加電圧強度が徐々に増大するバイポーラパルスからなり、その印加電圧強度に応じた階調を評価した。バイポーラパルスを用いたのは、偏った電圧印加による蓄積電荷のために液晶材料に電気化学的なダメージを与えないためである。更に、バイポーラパルス間の０Ｖ電圧の挿入は、印加電圧解除時の立ち下がり応答時間の計測のためである。

【００３９】また、電気光学特性の評価のための光学系を図16に示す。液晶の単安定時のダイレクタ（配向処理方向）に平行した偏光子（Ｐ方向）を配置し、検光子（Ａ方向）をそれと垂直に配置した。

【００４０】４．ＴＦＴ素子との組み合わせ

アクティブマトリックス素子としては、ビューファインダ用の 0.7インチ、10.3万画素のポリ－Ｓｉ－ＴＦＴを用いた。対向させるコモン電極はＲ、Ｇ、Ｂのカラーフィルタ付きの基板を用い、セルギャップは触媒化成工業の真糸球をスペーサとして用い、 1.2～1.5 μｍとした（図１参照）。液晶は減圧下で等方相温度で注入した。

【００４１】５．結果とその考察

（１）液晶の組織と電気光学特性

偏光顕微鏡下で液晶注入したセルを観察すると、平行配向セルでは、ＳＳＦＬＣによく見られるマルチドメイン組織を示し、その電気光学特性は±22Ｖ／μｍ印加で60μsec の応答時間を有し、双安定のメモリ性（メモリコーン角：40.5度）を示した。

【００４２】一方、反平行セルでは、ラビング処理方向に平行な 2.3μｍピッチの縞状組織を示した。このストライプは、液晶のダイレクタが配向処理方向に対して約±４度傾いた周期的構造であることが分かった。

【００４３】この反平行セルの電気光学特性は、電界を印加しないときには、液晶ダイレクタは偏光子又は検光子の偏光軸にほぼ平行となるために、透過率は常に０を示し、電界印加により光透過率はその極性に関係なく電界強度と共に増大する。この透過率変化は０～５Ｖの範囲では小さく、かつ高速であるが、５Ｖ以上では透過率変化は大きく、やや遅い。この閾値電圧を有する２段階のスイッチング挙動は、低電圧領域の連続的なチルト角

変化と、これに続くドメインスイッチングにより、説明できる。

【0044】更に、電界印加により傾斜した液晶ダイレクタが、電界の除去によりもとの配列状態に速やかに戻るという単安定性を示した。電界除去時のダイレクタの元の配列への復帰は、液晶分子がポリイミド配向膜による相互作用により束縛されたことが要因と考えられる。しかしながら、この系では、ストライプ組織のために最大コントラストが46と小さい。

【0045】（2）アナログ階調性の改善

コントラスト及びアナログ階調性を改善するために、セルを700Hz、20～50Ｖの交流電界印加により電界処理した。この電界処理により、規則的なストライプ組織から層の回転を伴い、モノドメイン組織へと変えることができる。このモノドメイン化によるストライプドメインの消失により、コントラストは81を達成した。

【0046】このモノドメイン組織における液晶ダイレクタの傾き角の電圧依存性を図17に示す。印加電圧強度の増大に伴い、傾き角は閾値電圧を待たず、低電圧から一様に増大し、約７Ｖで約22度傾斜することが分かる。更に、その印加電圧の極性がダイレクタの傾く方向を決定する。また、応答時間もストライプ組織の時よりも約1msecと高速化された。

【0047】また、このセルの透過率変化の一例を図18に示す。ここでの光透過率は10Ｖ印加時の透過率で規準化した。光透過率は０Ｖ～２Ｖまでほぼリニアに変化し、その後は緩やかな変化となり、６Ｖ～７Ｖ以上でほぼ一定となる。このように、電圧が印加されていないときには、液晶分子が配向膜界面で配向処理方向に並び、安定化した状態を実現した。また、直交した偏光子Ｐと検光子Ａの間に、単安定化した液晶分子の配向方向を偏光子Ｐに平行に配置することにより、低電圧での電圧の制御で光透過率を制御し、アナログ階調を実現できた。

【0048】単安定ＦＬＣでは複屈折モードを用いているため、最大透過率を得るためには見かけのチルト角は45度が望ましく、この時、ＴＮモードとほぼ同じ透過率となる。

【0049】更に、このデバイスの高速化、及び駆動温度範囲の拡大のために、液晶材料（ＦＬＣ３）を調製し、組み合わせる配向膜の検討を行い、次に示す単安定ＦＬＣ素子を実現した。但し、ＦＬＣ３の見かけのチルト角は約22度である。

【0050】（３）応答時間

図19、図20には、新たに見出した単安定ＦＬＣ組成物と配向膜とを組み合わせた単安定ＦＬＣ素子（ＦＬＣ３）の立ち上がり応答時間と立ち下がり応答時間の電圧依存性、温度特性を示す。室温で電圧依存性を見ると、電圧印加時の立ち上がり時間は電圧の増大に伴い高速化され、５Ｖで約50μsec にも達した。

【0051】一方、電圧除去時の応答時間（立ち下がり

時間）は、それまで印加されていた電圧、即ちダイレクタの傾き角の大きさには依存せずに一定であり、かつ約120μsec と高速である。

【0052】更に、応答時間は、立ち上がり、立ち下がり共に同様の温度依存性を示し、主に粘性の温度依存性の影響によるものと考えられる。それでも、－５℃においても１msec以下の応答時間を達成することができた。特に、立ち下がり時間が電圧に依らず一定で高速であるのは、電圧印加によって応答したＦＬＣ自身の自発分極による反電界の発生により、元の配向状態に戻ろうとするためであると考えられる。

【0053】（４）視野角特性

図21にＴＮ液晶素子の典型的な視野角特性を、図22に単安定ＦＬＣの視野角特性を示した。ここでの透過率は大塚電子社製のＬＣＤ評価装置（平行光源使用）を用いて測定し、視野角０度の最大透過率で規格化した。これらの視野角特性はいずれも、位相補償などによる広視野角化を行っていない上下方向の透過率変化である。

【0054】これによれば、ＴＮ液晶では、正面でのコントラストは100以上と大きいが、本質的に液晶分子配列にねじれ構造を有するために、視野角の変化に伴い黒レベル（０%）と、白レベル(100%）が共にコントラストを低下させる方向に変動する。そのために、コントラストの視野角依存性が大きい。更に、中間調レベル、例えば50%での変動が極めて大きいため、特に上下方向の視野角特性において階調の反転が生じてしまう。

【0055】しかしながら、単安定ＦＬＣ素子では、現状の正面でのコントラストは最大100程度であるが、液晶の配列構造にねじれのないこと及びこれによりオプティカルパスが短いことを反映して、視野角の変化に伴う黒レベル、白レベル、及び中間階調レベルの変動は非常に少なく、ＴＮ液晶に見られるような階調の反転挙動は見られず、視野角は全方位50度以上と広いことが特徴的である。

【0056】（５）ＴＦＴ素子との組み合わせ

下記の表２に、単安定ＦＬＣＤとＴＮ－ＬＣＤの視野角特性と応答時間をまとめた。

【0057】これによれば、単安定ＦＬＣＤでは、ＦＬＣの有する高速応答性と広視野角を活かして、アクティブマトリックス駆動が可能であることが分かる。そして、特徴的なのは、駆動電圧が５Ｖ程度とＦＬＣとしては比較的低電圧で駆動できるため、従来のＴＮ液晶用のＴＦＴ素子及び駆動回路を変更することなく、組み合わせ可能な点である。

【0058】これに反し、従来のＴＮ－ＬＣＤでは、立ち上がりと立ち下がりの応答時間の和 $\tau_r + \tau_f$ は25℃においても約30msecと遅く、１フィールドの16.7msecの画像情報を十分に再現できない。特に０℃では約90msecとなり、さらに尾引き現象は顕著になる。しかし、単安定ＦＬＣＤの応答時間 $\tau_r + \tau_f$ は25℃で 0.2msec、０

℃においても１msec以下であるため、各フィールドの中間階調の情報を忠実に再現できることが予想される。＊

＊【００５９】

表２（ＦＬＣとＴＮのデバイス性能の比較）

デバイス特性		単安定ＦＬＣＤｓ	ＴＮ－ＬＣＤｓ
視野角 ＣＲ＞３０	上	＞50°	10°
	下	＞50°	40°
	左	＞50°	45°
	右	＞50°	45°
応答時間 $\tau_r + \tau_f$	＋25℃	0.2msec	約30msec
	0℃	0.8msec	約90msec
モード		ノーマリブラック	ノーマリブラック又はノーマリホワイト

【００６０】単安定ＦＬＣＤを従来のＴＮ液晶用のＴＦＴアクティブマトリックス(0.7インチ、10.3万画素ビューファインダ用）と組み合わせたデバイス（これについては、後で詳しく説明する。）において、配向処理プロセスの改良、ギャップ精度の向上により、これまでは段差構造上では困難と考えられていたＦＬＣの均一な液晶配向性を達成した。

【００６１】駆動法として、ＴＮ液晶と同様、ライン反転或いはフィールド反転を適用することにより、上記の広い視野角を有するビデオレートのカラー表示を実現した。実際に、ビデオカメラでの撮像している被写体の高速な移動においても尾引きは非常に少ないことを確認した。

【００６２】駆動モードとしては、電界が offの時に暗レベルとなるノーマリブラックモードが、単安定ＦＬＣでは電気的中性を保つという点及び高コントラストという点で好ましい。

【００６３】次に、上記した本発明に基づく単安定ＦＬＣをアクティブマトリックス素子であるＴＦＴと組み合わせて表示デバイスを作製し、その特性を測定した例を詳細に説明する。

【００６４】<u>例１</u>（アクティブマトリックス駆動型単安定ＦＬＣ表示デバイスＩの作製）

アクティブマトリックスの素子としては、例えばＴＦＴ（Thin Film Transistor：薄膜トランジスタ）を用いることができる。ここでは、Ｒ、Ｇ、Ｂカラーフィルタ対応のＴＦＴ素子を用いた。

【００６５】図１に、カラーフィルタ付きアクティブマトリックス駆動型単安定ＦＬＣ表示デバイスＩの構成を示す。ガラス基板１ａ上のＴＦＴ６の側に宇部興産社製Ｕ－ワニスのＮ－メチル－２－ピロリドン溶液をスピンキャスト法により塗布し、 200℃で焼成し、 500Åのポリイミド配向膜５ａを形成し、更にアセテート系の布を巻いたローラでラビング配向処理をした。また、コモン電極４側は、ガラス基板１ｂ上にクロムのブラックマトリックス２、カラーフィルタ３、透明電極（ＩＴＯ）４をこの順番に形成し、その透明電極の面に上記と同様にポリイミド膜５ｂを形成し、ラビング配向処理を施した。

【００６６】このようにして作製した配向膜付きのＴＦＴ側パネルとカラーフィルタ側パネルとを、その配向処理方向が対向面で反平行となるように組み、そのスペーサ７として目的ギャップ長に応じたガラスビーズ（真糸球：直径 0.8～1.5 μｍ（触媒化成工業社製））を用いた。スペーサ７は周囲を接着するシール剤８（ＵＶ硬化型の接着剤（フォトレック：セキスイ化学（株）社製））中に 0.3wt％程度分散させることにより、基板間のギャップを制御し、かつ、セルの周囲を液晶の注入孔を確保して上記シール剤で接着した。

【００６７】その後、単安定強誘電性液晶組成物９を等方相温度又はカイラルネマチック相温度の流動性を示す状態で減圧下で注入した。液晶注入後、徐冷し、注入孔周囲のガラス基板上の液晶を除去した後、ＵＶ硬化型接着剤で封止し、単安定強誘電性液晶素子を作製した。ここで用いた強誘電性液晶９は上記した表１に記載のＦＬＣ３（ピッチ長10μｍ、自発分極16nC/cm^2）又は本出願人による特願平３－２５１３１号による組成物、例えばフェニルピリミジン系液晶ＦＬＣ２（カイラル成分２wt

%、ピッチ長21.2μm、自発分極 2.5nC/cm^2)を用いた。

【0068】上記の各パネルに配向処理方向と平行又は直交して偏光板10a、10bを設け、デバイス両面に配置した。配置した偏光板10は互いに直交させた。更に、このパネルのTFT素子側にバックライト11を配置することにより、単安定強誘電性液晶表示デバイスIを完成した。

【0069】例2(アクティブマトリックス駆動型単安定FLC表示デバイスIの駆動)

カラーフィルタ用アクティブマトリックスの素子構成のレイアウトを図2に示す。NTSC信号をデコーダによりR、G、Bの各輝度信号に変換し、同時にTFTを駆*

*動するためのH、Vシフトレジスタ用クロックパルスをパルスドライバから発生させた。このTFTパネルにおける各端子信号について下記の表3にまとめて示す。

【0070】この表示デバイスIの駆動に際しては、各端子から下記の表3に示す所定の信号をHシフトレジスタから各ゲートトランジスタTRを介して選択的にTFTに入力し、Vシフトレジスタからのゲート制御信号に応じて、TFTによって単安定FLC9にスイッチング電圧を印加する(Csは信号電荷を1フレーム時間蓄積するためのキャパシタ、COMはコモン電位を供給する素子部である)。

【0071】

表3A(TFTパネルの端子信号)

端子番号	端子記号	電　圧	端 子 説 明
1	GREEN	10.5V(DC)	ビデオ信号(G)入力
2	RED	10.5V(DC)	ビデオ信号(R)入力
3	BLUE	10.5V(DC)	ビデオ信号(B)入力
4	HVSS	0V	Hドライバ用GND端子
5	TP1	OPEN	テスト端子
6*	HCK1	定格クロック	Hシフトレジスタ駆動用クロック入力端子
7*	HCK2	定格クロック	Hシフトレジスタ駆動用クロック入力端子
8	HST	定格クロック	Hシフトレジスタ駆動用スタートパルス入力端子

【0072】

表３Ｂ（ＴＦＴパネルの端子信号）

端子番号	端子記号	電　圧	端　子　説　明
9	HVDD	12Ｖ(DC)	Ｈドライバ用電源入力端子
10*	VCK2	定格クロック又は12Ｖ(DC)	Ｖシフトレジスタ駆動用クロック入力端子
11*	VCK1		Ｖシフトレジスタ駆動用クロック入力端子
12	VVSS	０Ｖ	ＶドライバＧＮＤ端子
13	VST	12Ｖ(DC)	Ｖシフトレジスタ駆動用スタートパルス入力端子
14	VVDD	13.5Ｖ(DC)	Ｖドライバ用電源入力端子
15	TP2	OPEN	テスト端子
16	VCOM	６Ｖ(DC)	パネルの対向電圧入力端子

＊ＨとＶの位相 180度、周波数は任意。
この電圧印加で液晶に＋4.5 ＶのＤＣが印加される。

【００７３】この例では、60Hzのフィールド周波数で画像表示したところ、 200マイクロ秒以下と高速で、±50度以上の広い視野角を有するディスプレイを実現できた。

【００７４】例３（カラーフィルタのないアクティブマトリックス駆動型単安定ＦＬＣ表示デバイスIIの作製）
アクティブマトリックス素子としては、例えばＴＦＴ（Thin Film Transistor：薄膜トランジスタ）を用いることができる。ここでは、モノクロ用のＴＦＴ素子を用いた。

【００７５】図３に、カラーフィルタレスのアクティブマトリックス駆動型単安定ＦＬＣ表示デバイスIIの構成を示す。ガラス基板１ａのＴＦＴ６の側に宇部興産社製Ｕ－ワニスのＮ－メチル－２－ピロリドン溶液をスピンキャスト法により塗布し、 200℃で焼成し、 500Åのポリイミド配向膜５ａを形成し、更にアセテート系の布を巻いたローラでラビング配向処理をした。また、コモン電極４の側は、ガラス基板１ｂ上にクロムのブラックマトリックス２、透明電極（ＩＴＯ）４をこの順番に形成し、その透明電極面４に同様にポリイミド膜５ｂを形成し、ラビング配向処理を施した。

【００７６】このようにして作製した配向膜付きのＴＦＴ側パネルとカラーフィルタ側パネルとを、その配向処理方向が対向面で反平行となるように組み、そのスペーサ７として目的ギャップ長に応じたガラスビーズ（真糸球：直径 0.8～1.5 μｍ（触媒化成工業社製））を用いた。スペーサ７は周囲を接着するシール剤８（ＵＶ硬化型の接着剤（フォトレック：セキスイ化学（株）社製））中に 0.3wt％程度分散させることにより、基板間のギャップを制御し、かつ、セルの周囲を液晶の注入孔を確保して上記シール剤で接着した。

【００７７】その後、単安定強誘電性液晶組成物９を等方相温度又はカイラルネマチック相温度の流動性を示す状態で減圧下で注入した。液晶注入後、徐冷し、注入孔周囲のガラス基板上の液晶を除去した後、ＵＶ硬化型接着剤で封止し、単安定強誘電性液晶素子を作製した。ここで用いた強誘電性液晶９は例１と同様の組成物を用いた。

【００７８】上記の各パネルに配向処理方向と平行又は直交して偏光板10ａ、10ｂを設け、デバイス両面に配置した。配置した偏光板10は互いに直交させた。更に、このパネルのＴＦＴ素子側にバックライト11を配置することにより、カラーフィルタレスの単安定強誘電性液晶表示デバイスIIを完成した（但し、カラーフィルタは、ＦＬＣ素子とは別に設けるが、ここでは図示省略した：後記の図12参照）。

【００７９】例４（アクティブマトリックス駆動型単安定ＦＬＣ表示デバイスIIの駆動）
カラーフィルタレス（モノクロ）用アクティブマトリックスの素子構成のレイアウトを図４に示す。ＮＴＳＣ信

号をデコーダによりR、G、B信号に変換し、同時にTFTを駆動するためのH、Vシフトレジスタ用クロックパルスをパルスドライバから発生させた。このTFTパネルにおける各端子信号については上記の表3に示したが、この例では、各R、G、Bの各輝度信号を3番の共通端子から入力した。

【0080】この例でも、60Hzのフィールド周波数で画像表示したところ、200マイクロ秒以下と高速で、±50度以上の広い視野角を有するディスプレイを実現できた。しかも、カラーフィルタレスでR、G、Bの各信号を共通端子から入力できるため、カラーフィルタ用のTFTに比較して、有効な画素数を3倍にすることができ、高解像度化が可能である。

【0081】例5（色順次切り替え用液晶フィルタの作製方法）

セルの構成は図5に示す通りである。即ち、透明ガラス基板1a、1b上に透明電極4a、4b(100Ω／□のITO）を付け、更にその上に液晶配向膜としてSiOの斜方蒸着膜5a、5bを形成した。このSiO斜方蒸着膜の形成方法としては、真空蒸着装置内に、SiO蒸着源から鉛直上に基板を配し、鉛直の線と基板法線のなす角を85度として設置した。SiOを基板温度 170℃で真空蒸着後、300℃、1時間の焼成を行った。

【0082】このようにして作製した配向膜付きの基板をその配向処理方向が対向面で反平行となるように組み、そのスペーサ7として目的ギャップ長に応じたガラスビーズ（真糸球：直径 0.8〜3.0 μm（触媒化成工業＊社製））を用いた。スペーサ7は透明基板の大きさにより小さい面積の場合は周囲を接着するシール剤8（UV硬化型の接着剤（フォトレック：セキスイ化学（株）社製））中に0.3wt%程度分散させることにより、基板間のギャップを制御した。更に基板面積が大きい場合には、上記真糸球を基板上に平均密度で 100個／mm^2 散布したのち、ギャップをとり、セルの周囲を液晶の注入孔を確保して上記シール剤で接着した。

【0083】その後、強誘電性液晶9（例えばチッソ（株）社製CS－1014）を等方相温度又はカイラルネマチック相温度の流動性を示す状態で減圧下で注入した。液晶注入後、徐冷し、注入孔周囲のガラス基板上の液晶を除去した後、エポキシ系の接着剤で封止し、強誘電性液晶素子を作製した。

【0084】用いる強誘電性液晶はチッソ（株）社製、メルク（株）社製、BDH社製、或いは他の公知の強誘電性液晶化合物又は非カイラル液晶との組成物でも可能であるが、その制限はなく、その相系列の制限も必要とせず、必要なのは使用温度範囲でカイラルスメクチック液晶相をとることである。更に、カイラルスメクチック液晶以外でもスイッチングスピードが高速であれば、例えば、反強誘電性液晶（AFLC）や電傾効果を示すスメクチックA相でも適用可能である。

【0085】この例による色順次切り替え用液晶フィルタの電気光学特性は下記の表4に示す通りである。

【0086】

【表1】

表4（FLC素子の電気光学特性）

FLCサンプル	ギャップ (μm)	レタデーション (nm)	見かけのコーン角 (deg)	方形波 印加電圧	方形波 応答時間 10-90%T	方形波 応答時間 90-10%T	パルス駆動 印加電圧	パルス駆動 パルス幅	パルス駆動 応答時間 10-90%T	パルス駆動 応答時間 90-10%T
CS-1014	2.10	263.7	46.5	30Hz, ±15V	118μs	100μs	±20V	425μs	61μs	56μs
							±30V	254μs	40μs	36μs

【0087】これによれば、この液晶フィルタ（FLC液晶素子）は、使用光学波長の約半分の位相差を示しており、入射光の偏光面を約90度回転できるスペックを有していることが分かる。

【0088】例6（色順次切り替え用液晶フィルタの駆動波形）

例5の強誘電性液晶素子の駆動法としては、従来の一般的なFLCの駆動法が適用できる。図6〜図9に、1フレーム内でスイッチ状態を1回切り替える駆動波形の一例を示す。

【0089】図6は方形波駆動である。1フレームで電気的中性条件を保つ方法であって、パルス駆動に比べてDC電圧が印加されている時間が長いが、素子の絶縁性が高い場合には信頼性の高い駆動法である。FLCの他、AFLC、電傾効果型スメクチックAにも使用できる。

【0090】図7はリセットパルス付きのパルス駆動であり、書き込み直前にリセットパルスを加えてフィールド内での電気的中性条件を保つ方法であり、液晶に長時間の直流成分が印加され難い。

【0091】図8はリセットパルス無しのパルス駆動であり、1フレーム内での電気的中性条件を保つ方法である。

【0092】図9はリセットパルス無しのパルス駆動であり、パルス印加後の印加電圧保持により、メモリー効果の少ない液晶材料系でもスイッチ状態を保持でき、同時に1フレーム内での電気的中性条件を保つ方法である。FLCの他、AFLCにも使用できる。

【0093】上記の駆動波形によるスイッチング特性を上記の表4に示した。立ち上がり（10−90%T）及び立ち下がり（90−10%T）とも、いずれもマイクロ秒オーダーの高速応答を示しており、1フィールド内での十分

な応答を保証している。

【0094】例7（色順次駆動型単安定ＦＬＣ表示デバイスの構成）

例５（又は例３）のＦＬＣ素子（スイッチ素子）とカラー偏光板（カラーフィルタ）とを組み合わせることにより、透過光の色をＲ、Ｇ、Ｂに切り替え可能な素子を実現できる。図10に、色順次駆動単安定ＦＬＣ表示デバイスの構成を示す。

【0095】即ち、例３で作製した図３のモノクロタイプのアクティブマトリックス駆動型単安定ＦＬＣ表示デバイスの偏光板10Ｂ（Ｐ１）の前面に高速で偏光面を90°回転することのできるＦＬＣ素子12ａ（ＦＬＣ１）、カラー偏光板13（Ｐ２）、ＦＬＣ素子12ｂ（ＦＬＣ２）、カラー偏光板14（Ｐ３）をこの順に配置した。ＦＬＣ１、ＦＬＣ２の異常光軸のスイッチ状態１の方向を偏光板10ｂ（Ｐ１）の光透過容易軸に対して直交或いは平行に配置し、更に、偏光板Ｐ１の光透過容易軸に対してカラー偏光板Ｐ２のＢ光透過容易軸、カラー偏光板Ｐ３のＲ光透過容易軸を平行に配置した。

【0096】スイッチ状態１とスイッチ状態２では、異常光軸が約45°傾斜しており、そのレタデーションを270nmとすることにより、例えば、偏光板Ｐ１を通ったＲ、Ｇ、Ｂ光はＦＬＣ１のスイッチ状態が15（スイッチ状態１）の時、偏光面の回転を受けないでカラー偏光板Ｐ２のＢ光透過容易軸に平行に入射するために、カラー偏光板Ｐ２を透過するのはＢ光だけとなる。＊

＊【0097】この時、ＦＬＣ２のスイッチ状態が15であれば、同様にＢ光は偏光面の回転を受けずにカラー偏光板Ｐ３のＲ光透過容易軸に平行に入射するため、Ｂ光は透過できず、黒となる。即ち、この場合は、単安定ＦＬＣ素子での階調に拘わらず、常に黒を実現できる。

【0098】一方、偏光板Ｐ１を通ったＲ、Ｇ、Ｂ光はＦＬＣ１のスイッチ状態が16（スイッチ状態２）の時、偏光面は90°回転し、カラー偏光板Ｐ２のＲ、Ｇ光透過容易軸に平行に入射するために、カラー偏光板Ｐ２を透過するのはＲ、Ｇ光だけとなる。

【0099】この時、ＦＬＣ２のスイッチ状態が15であれば、Ｒ、Ｇ光は偏光面の回転を受けずにカラー偏光板Ｐ３のＧ、Ｂ光透過容易軸に平行に入射するため、Ｒ光は透過できず、Ｇだけ透過する。即ち、この場合は、単安定ＦＬＣ素子での階調に応じた緑の表示を実現できる。

【0100】また、この時、ＦＬＣ２のスイッチ状態が16であれば、同様にＲ、Ｇ光偏光面は90°回転し、カラー偏光板Ｐ３のＲ光透過容易軸に平行に入射するため、Ｇ光は透過できず、Ｒだけ透過する。即ち、この場合は、単安定ＦＬＣ素子での階調に応じた赤の表示を実現できる。

【0101】下記の表５に、ＦＬＣ１とＦＬＣ２のスイッチ状態と透過光の種類についてまとめた。

【0102】

表５（ＦＬＣ１とＦＬＣ２のスイッチ状態と透過光の種類）

ＦＬＣ１	ＦＬＣ２	表示色	階調性
スイッチ状態１	スイッチ状態１	黒	なし
スイッチ状態１	スイッチ状態２（90°回転）	青	あり
スイッチ状態２（90°回転）	スイッチ状態１	緑	あり
スイッチ状態２（90°回転）	スイッチ状態２（90°回転）	赤	あり

【0103】このように、ＦＬＣ素子ＦＬＣ１とＦＬＣ２のスイッチ状態の組み合わせにより、色の切り替えが可能であった。

【0104】例8（色順次駆動法）

例５で作製したパネルの駆動法について説明する。図11に、色順次駆動型単安定ＦＬＣ表示デバイスの駆動回路の構成を示す。

【0105】入力信号はＮＴＳＣ、Ｙ／Ｃ、ＲＧＢ信号を問わないが、デコーダによりＲ、Ｇ、Ｂ信号にし、１フィールド分をフィールドメモリ１に取り込む。次のフィールドを取り込む前に、次のバッファメモリ（フィールドメモリ）２へ転送しておく。更に、次のフィールドを取り込んでいる間に、パルスドライバからのシフトレジスタ駆動パルスに同期させて、バッファメモリ２からＲ信号、Ｇ信号、Ｂ信号を単安定ＦＬＣ素子の信号端子３番に入力し、同時に色順次切り替えをそれと同期させて行うことにより、フルカラーの表示素子を実現できる。

【０１０６】この色順次駆動型単安定ＦＬＣ表示デバイスの駆動のタイミングテーブルを図12に示す。ここでは、１フィールド内にＲ、Ｇ、Ｂを各１回点灯する方法（図６の方形波を使用）において、単安定ＦＬＣへの書き込み過程では、色フィルタを黒の状態にして画質の劣化を防止しているのが特徴的である。

【０１０７】通常、ＮＴＳＣ方式では、１フィールドは1/60 秒であり、各色は、書き込み過程とホールド時を含めて 16.67秒で完了しなければならない。しかしながら、１フィールド内で、Ｒ、Ｇ、Ｂを各１回書き込むだけでは、その表示特性はいわゆる色割れ（画像のエッジでＲ、Ｇ、Ｂの各色が別れて表示される。）を生じてしまう。

【０１０８】そのために、Ｒ、Ｇ、Ｂを２回（Ｒ／Ｇ／Ｂ／Ｒ／Ｇ／Ｂ）或いは３回（Ｒ／Ｇ／Ｂ／Ｒ／Ｇ／Ｂ／Ｒ／Ｇ／Ｂ）繰り返すことにより、色割れを減ずることができる。しかしながら、１回の場合には各スイッチ状態は１/180秒、２回の場合には各スイッチ状態は１/360秒、３回の場合には各スイッチ状態は１/540秒（1.85 msec）の期間しか与えられていないため、色フィルタの切り替え速度はかなりの高速性が要求される。

【０１０９】そこで、液晶素子として上記のＦＬＣ（強誘電性液晶）であれば、上記の表４や図19に示したように立ち上がり時間は 0.1msec以下を達成できるため、上記の切り替え速度に対応した十分高速なスイッチングが可能となった。

【０１１０】以上、本発明を実施例について説明したが、上述した実施例は本発明の技術的思想に基づいて更に変形が可能である。

【０１１１】例えば、液晶の種類をはじめ、液晶素子の各構成部分の材質、構造、形状、組み立て方法等は種々に変更することができる。基板（例えば上述の１ａ、１ｂ）はディスプレイとして、少なくとも一方が光学的に透明であればよい。

【０１１２】なお、上述した実施例では、表示素子に好適な液晶素子について説明したが、表示素子では特に階調性（中間調）を実現できる点で好ましいものである。しかし、本発明は、表示素子に限らず、液晶素子をフィルタやシャッタ、ＯＡ機器のディスプレイ画面、スクリーンやウォブリング用の位相制御素子等にも適用可能である。

【０１１３】

【発明の作用効果】本発明の液晶素子によれば、上述した如く、単安定強誘電性液晶素子（単安定ＦＬＣ素子）と、この液晶素子を駆動するＴＦＴ等のアクティブマトリックス素子と、フィルタ素子とを組み合わせているので、液晶素子として単安定ＦＬＣ素子を用いていることによって、ＴＮ素子では不可能であった、広視野角で１msec以下の高速応答性の表示を階調性良く実現することができる。

【０１１４】このような広視野角、高速応答性の単安定ＦＬＣ素子をＴＦＴ等のアクティブマトリックス素子で駆動し、フィルタ素子（特に１msec以下で色順次に切り替え可能なカラーフィルタ等のフィルタ素子）によって、対応する色の表示を再現性良く高階調度に得ることができる。

【図面の簡単な説明】

【図１】本発明に基づく液晶表示デバイスの概略断面図である。

【図２】同駆動用のアクティブマトリックスのレイアウト図である。

【図３】本発明に基づく他の液晶表示デバイスの概略断面図である。

【図４】同駆動用のアクティブマトリックスのレイアウト図である。

【図５】本発明に使用可能な液晶セルの概略断面図である。

【図６】液晶素子の駆動波形図である。

【図７】同液晶素子の他の駆動波形図である。

【図８】同液晶素子の他の駆動波形図である。

【図９】同液晶素子の更に他の駆動波形図である。

【図10】本発明に基づく色順次駆動型単安定ＦＬＣ素子デバイスの概略分解斜視図である。

【図11】同表示デバイスの駆動回路図である。

【図12】同表示デバイスの駆動時のタイミングテーブルである。

【図13】本発明に使用可能な単安定ＦＬＣ素子のモードを示す説明図である。

【図14】同単安定ＦＬＣの分子構造図である。

【図15】同単安定ＦＬＣ素子の電気光学特性図である。

【図16】同単安定ＦＬＣ素子の電気光学特性評価のために用いる光学系の説明図である。

【図17】同単安定ＦＬＣ素子のチルト角の印加電圧依存性を示すグラフである。

【図18】同単安定ＦＬＣ素子の透過率の印加電圧依存性を示すグラフである。

【図19】同単安定ＦＬＣ素子の立ち上がり時間の温度及び印加電圧依存性を示すグラフである。

【図20】同単安定ＦＬＣ素子の立ち下がり時間の温度依存性を示すグラフである。

【図21】従来のＴＮ素子の透過率の視野角依存性を示すグラフである。

【図22】本発明に使用可能な単安定ＦＬＣ素子の透過率の視野角依存性を示すグラフである。

【図23】従来の双安定ＦＬＣ素子のモードを示す説明図である。

【符号の説明】

１ａ、１ｂ・・・基板

２・・・ブラックマトリックス

３・・・カラーフィルタ

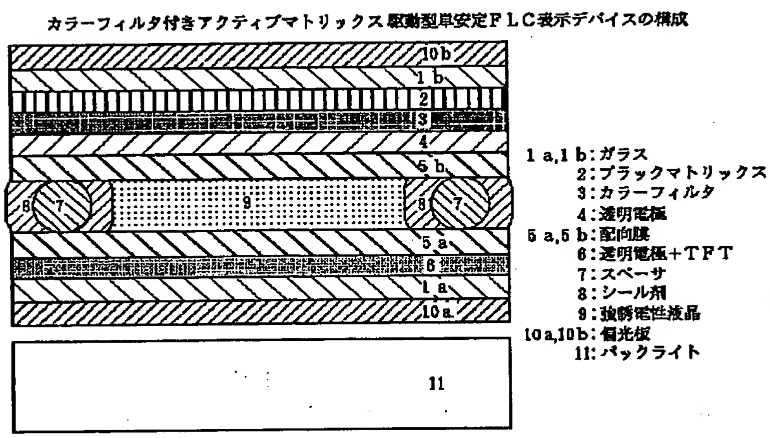
21

4・・・透明電極層
5a、5b・・・液晶配向膜（液晶配向膜制御層）
6・・・透明電極及びTFT
9、12a、12b、FLC・・・強誘電性液晶又は素子

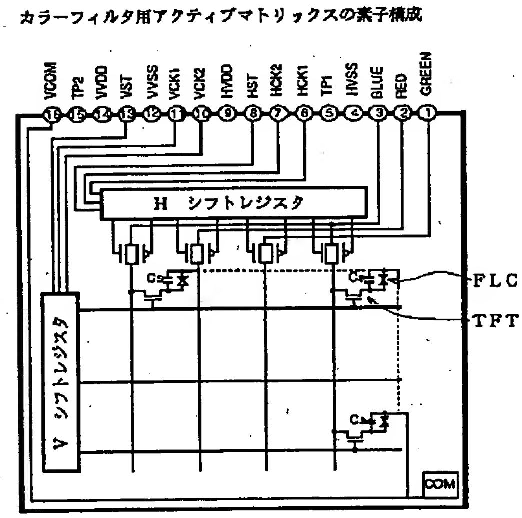
22

10a、10b・・・偏光板
11・・・バックライト
13、14・・・カラー偏光板
TFT・・・薄膜トランジスタ

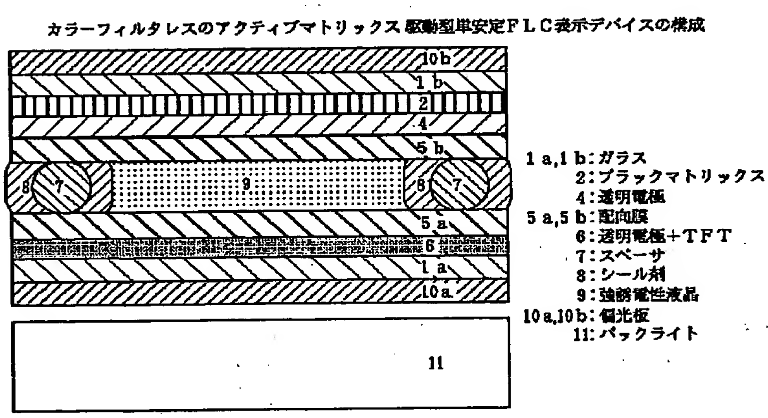
【図1】



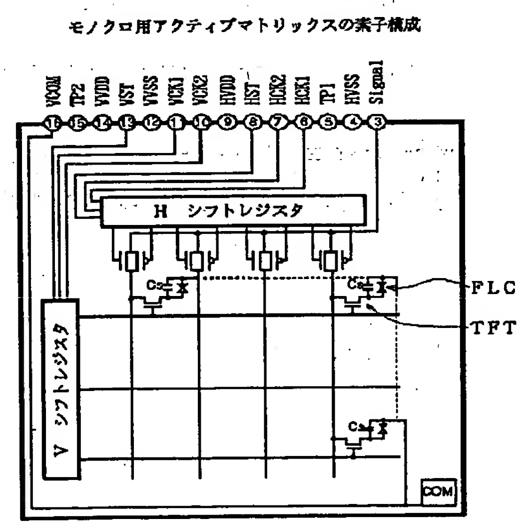
【図2】



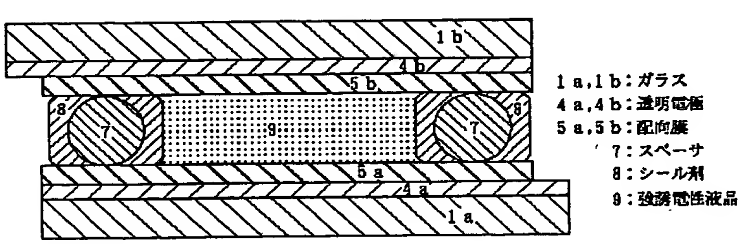
【図3】



【図4】

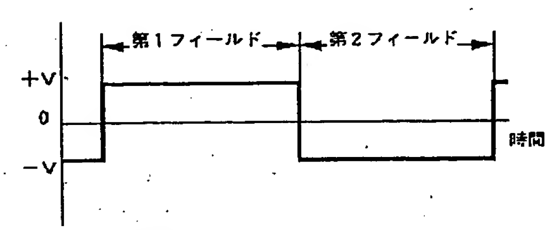


【図5】



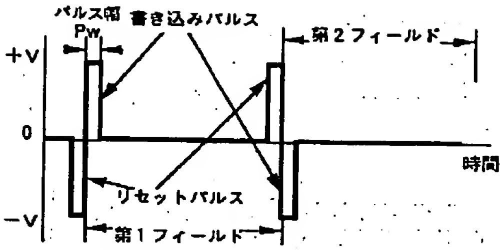
セルの構成

【図6】



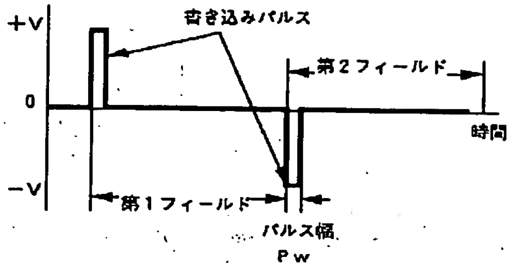
方形波駆動

【図7】



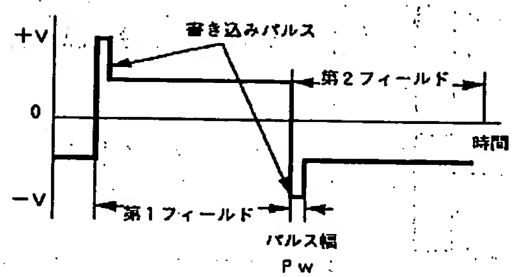
パルス駆動（リセットパルス付き）

【図8】



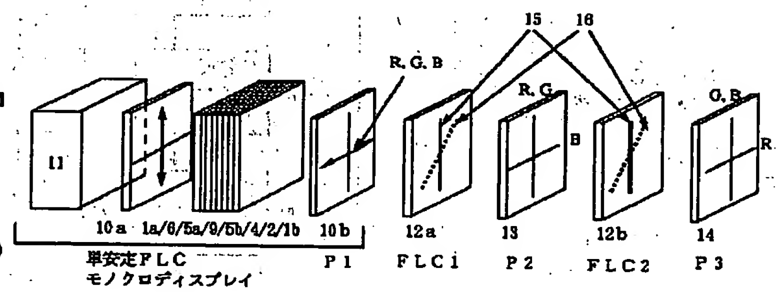
パルス駆動（リセットパルスなし）

【図9】



パルス駆動（リセットパルスなし、保持電圧印加）

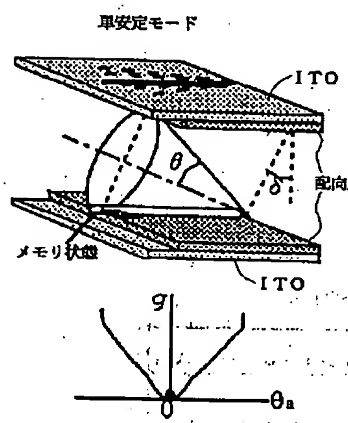
【図10】



10a, 10b：ニュートラル偏光板
11：バックライト
12a, 12b：FLC素子
13：カラー偏光板
14：カラー偏光板
15：液晶スイッチ状態1
16：液晶スイッチ状態2

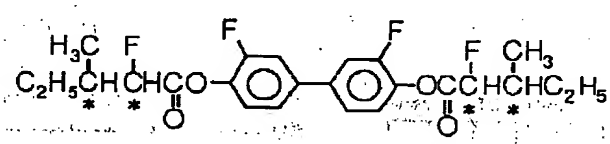
色順次駆動単安定FLC表示デバイスの構成

【図13】

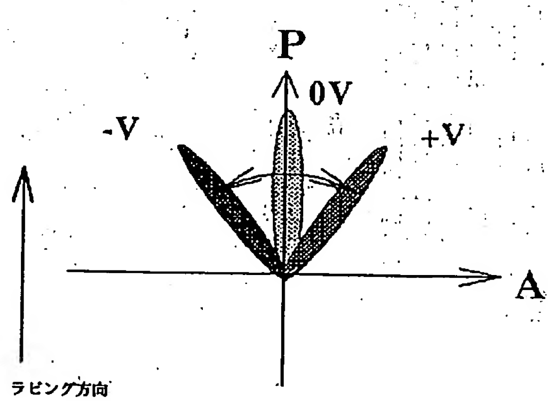


【図14】

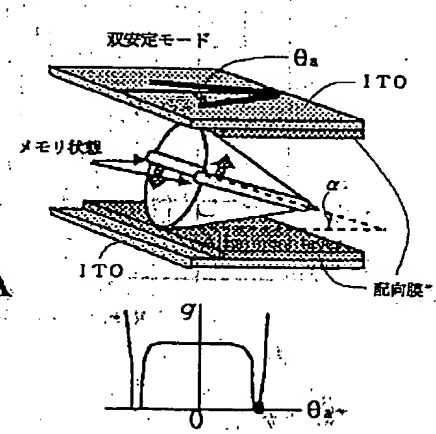
単安定FLCの分子構造



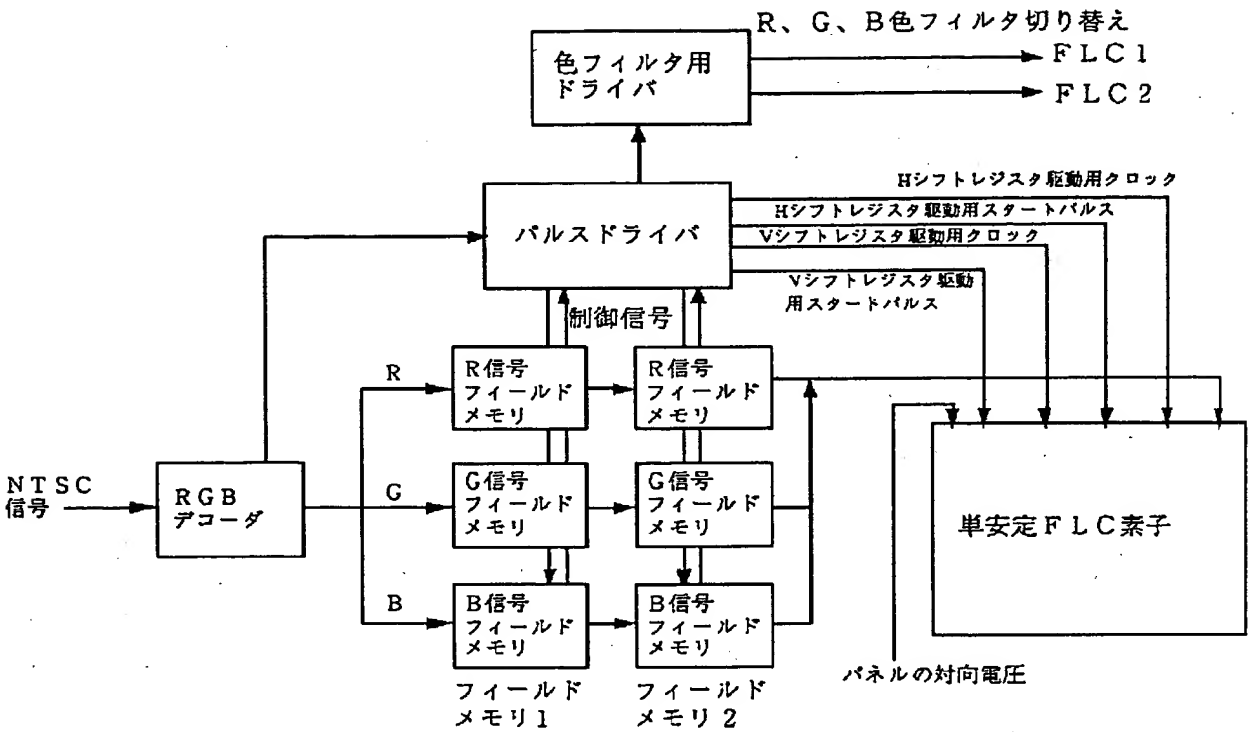
【図16】



【図23】

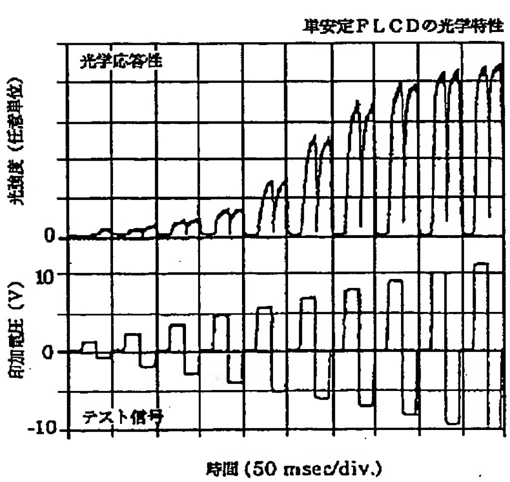


【図11】

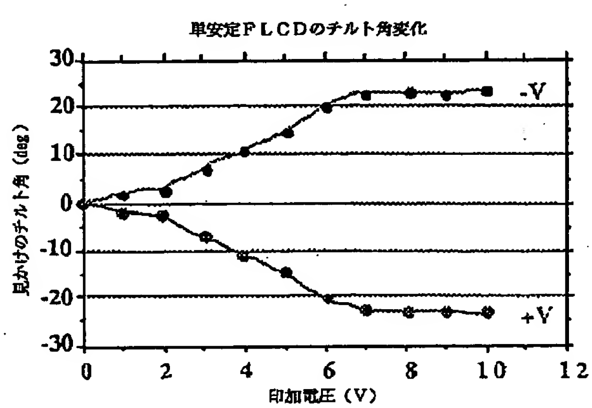


色順次駆動型単安定FLC表示デバイスの駆動回路

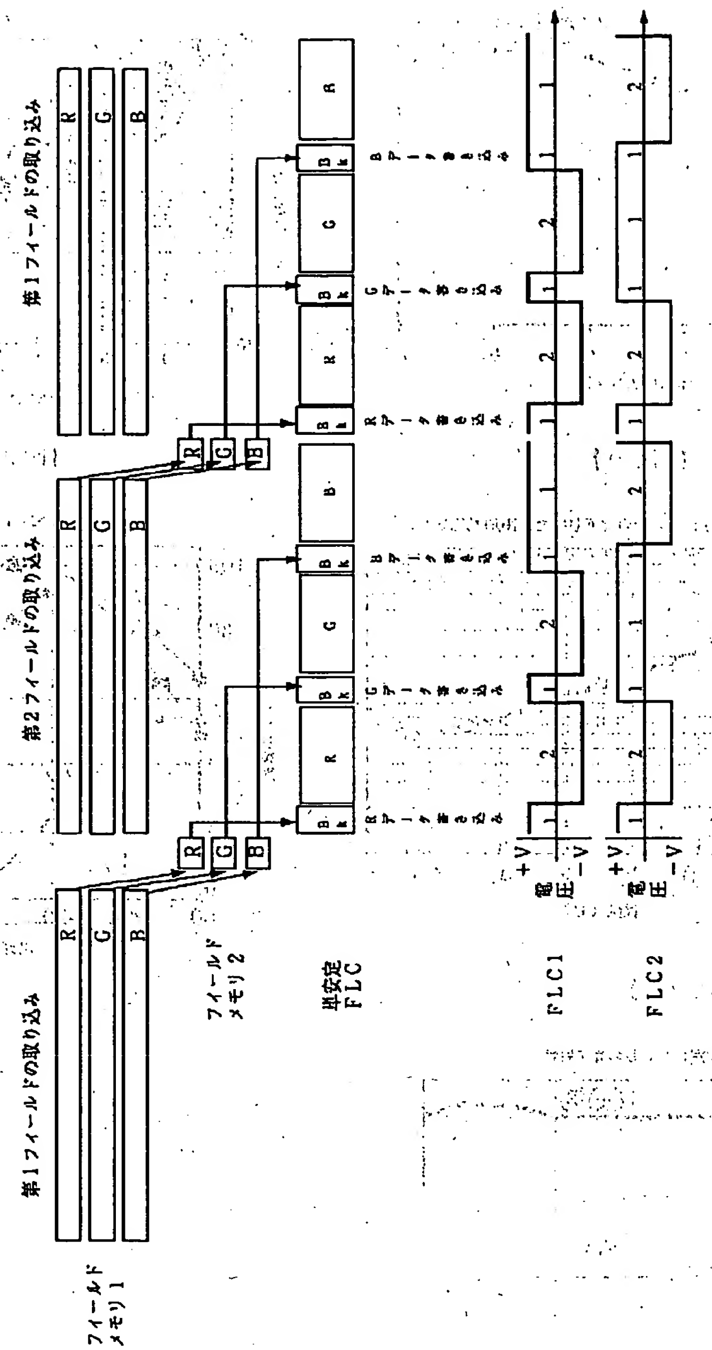
【図15】



【図17】

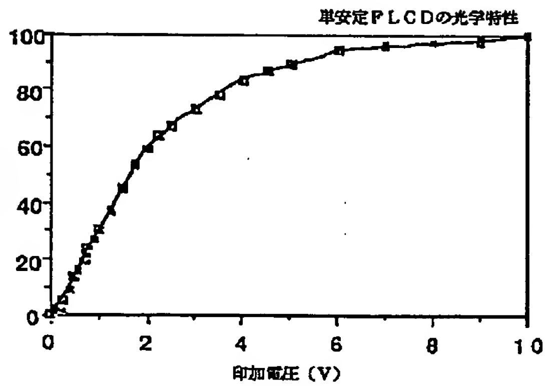


【図12】

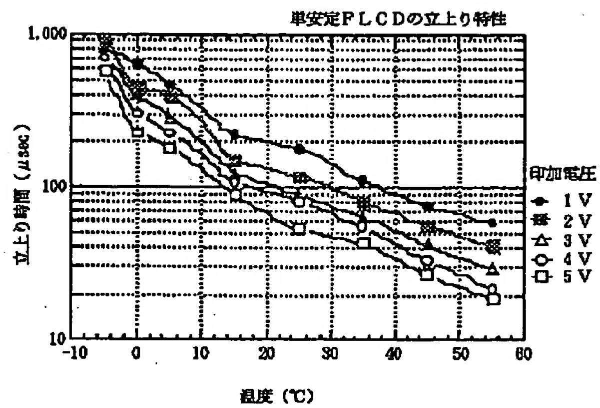


色順次駆動型単安定FLC表示デバイスの駆動のタイミングテーブル

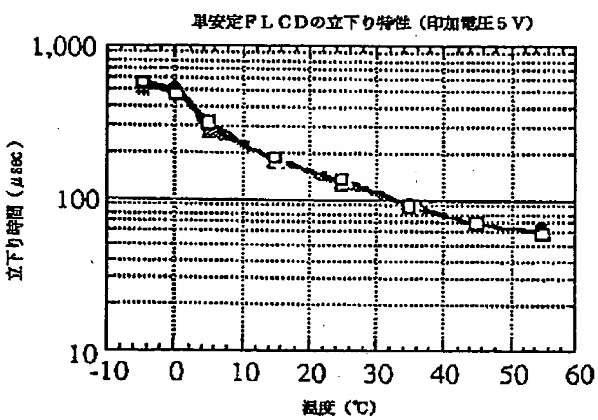
【図18】



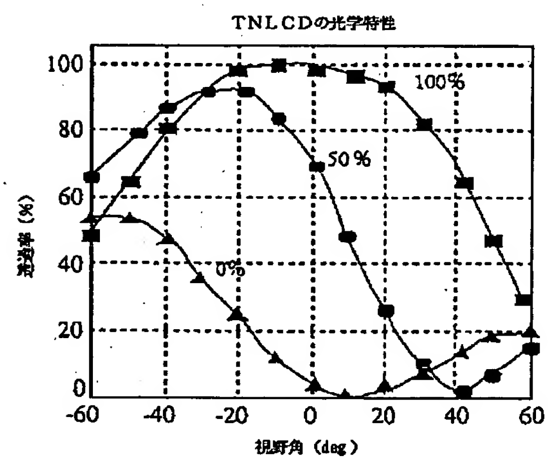
【図19】



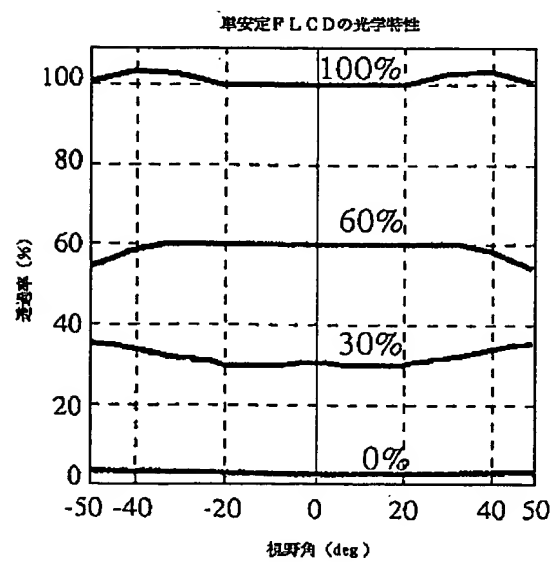
【図20】



【図21】



【図22】



CLAIMS

[Claim(s)]

[Claim 1] Liquid crystal equipment which combined the monostable ferroelectric liquid crystal component, the active-matrix component which drives this liquid crystal device, and the filter element.

[Claim 2] Equipment which a monostable ferroelectric liquid crystal component has the response time of 1 or less msec, and was indicated to claim 1 with a filter element switchable to color sequential at 1 or less msec.

[Claim 3] Equipment with which the display device of monochrome is constituted combining a monostable ferroelectric liquid crystal component and an active-matrix component, and the filter element is arranged between this display device and a display observation post and which was indicated to claim 1 or 2.

[Claim 4] Equipment which is constituted as a display device of a color combining the monostable ferroelectric liquid crystal component, the active-matrix component, and the color filter component and which was indicated to claim 1 or 2.

[Claim 5] The drive approach of the liquid crystal equipment which faces driving the liquid crystal equipment indicated in any 1 term of claims 1-4, drives a monostable ferroelectric liquid crystal component and changes a filter element by the active-matrix component synchronizing with this drive.

[Claim 6] The approach of driving a monostable ferroelectric liquid crystal component in the response time of 1 or less msec, and also performing the change of a filter element by 1 or less msec which indicated to claim 5.

[Claim 7] The approach of having indicated to claim 5 or 6 which changes a filter element into a black condition in the information write-in process over a monostable ferroelectric liquid crystal component.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to liquid crystal equipment (for example, display using the ferroelectric liquid crystal component with which the substrate of the pair which prepared a transparent electrode and the orientation film in this order keeps a predetermined gap, and opposite arrangement is carried out and which is matched with the ferroelectric liquid crystal in said gap), and its drive approach.
[0002]
[Description of the Prior Art] As for a liquid crystal display component, the need as a flat-panel display is being extended from the advantage that it can drive, with a low power with a thin shape. Especially, with the twist nematic liquid crystal display component (TN-LCD) of an active-matrix drive, the image quality is improving by leaps and bounds in recent years.
[0003] However, since TN liquid crystal has torsion of molecular orientation with big-screen-izing of a display, after-images, such as straitness of an angle of visibility, reversal of gradation, and tailing produced since the speed of response is still slower, pose a problem.
[0004] Although technique, such as cancellation of the twist structure by adoption of a phase compensation film and the device of the orientation film, is being developed about expansion of an angle of visibility, it is still inadequate. Moreover, even if it makes driver voltage high, of course by the driver voltage of the present TFT (thin film transistor) about a speed of response, since the response time of a return in the twist structure at the time of electrolysis removal cannot be shortened to dozens of or less mses, by Nor Marie White's display device, its response to white from black is very slow, and it brings a result in which especially after-images, such as tailing, are conspicuous.
[0005] As this wide-field-of-view angle and a liquid crystal ingredient which realizes a high-speed response to coincidence, a ferroelectric liquid crystal (ferroelectric liquidcrystals (FLCs)) can be considered. By the passive matrix drive, on the 1000 or more number of scanning lines and a wide-field-of-view square, a surface stability mold ferroelectric liquid crystal display device (SSFLCD) is expected by about 1000 times as much high-speed responsibility as TN liquid crystal and memory nature as a technique of realizing a cheap big screen flat-panel display, and is examined.
[0006] In such a ferroelectric liquid crystal (further liquid crystal of antiferroelectricity liquid crystal) The switching behavior of the liquid crystalline director by electrolysis impression moves on a cone with an imagination liquid crystal molecule according to the Minabe-gold stone mode indicated by the liquid crystal lexicon p150 (Baifukan). Furthermore, in the smectic A liquid crystal (liquid crystal lexicon p145 (Baifukan)) which has an electroclinic effect, even when the software mode indicated by the liquid crystal lexicon p119 (Baifukan) is used, it has the cone angle of a proper in each liquid crystal constituent similar to a cone angle.
[0007] That is, the cone model of the liquid crystal inserted into inter-electrode as shown in drawing 23 is considered. The projection to the glass substrate to which the transparent electrode of cone angle thetar, a call, and this cone angle was attached in the aperture angle of a cone is called apparent cone angle thetaa. What is necessary is optically, just to consider cone

angle thetaa of this appearance. The angle which the liquid crystalline director in two switch conditions makes about measurement of a cone angle here is measured, and it specifically asked for the liquid crystal cell under the polarization microscope with which the polarizer intersected perpendicularly from the angle of rotation of the stage in an extinction position (location which rotates and becomes dark).
[0008] However, in the conventional FLC, especially SSFLCD, although high-speed responsibility is shown for the strong interaction of the permanent dipole of an FLC molecule, and electric field, as shown in drawing 23, a liquid crystal molecule is bistability-ized by the restraint from an orientation film molecule.
[0009] Therefore, angle-of-inclination thetaa could be continuously controlled by switching between 2 conditions of this isoenergetic for the steep threshold property over electrical-potential-difference impression, and ** and a gradation display were difficult.
[0010] As gradation NOT-AND operation notation in the passive drive of SSFLCD, digital approaches, such as the area gradation method for having divided the time integration method and one drawing, are proposed. However, by this digital method, it has come to obtain the still sufficient number of gradation.
[0011] The gradation notation which does not use bistability memory nature is also proposed by on the other hand recently combining the active-matrix component and FLC which are used in TN liquid crystal device.
[0012] For example, gradation control is carried out, when the pitch length in a chiral smectic C phase dispels the distorted helical structure by electric-field impression using FLC shorter than optical wavelength and controls the average inclination of a liquid crystalline director. However, since liquid crystal orientation has stripes-like organization, the contrast is low.
[0013]
[Problem(s) to be Solved by the Invention] The purpose of this invention has high-speed responsibility on a wide-field-of-view square, enables a gradation display and is to offer the liquid crystal equipment (especially full color display) which resolution may also raise further, and its drive approach.
[0014]
[Means for Solving the Problem] That is, this invention relates to the liquid crystal equipment (LCD) which combined a monostable ferroelectric liquid crystal component (monostable FLC component), active-matrix components, such as TFT which drives this liquid crystal device, and a filter element.
[0015] Since the monostable FLC component is used as a liquid crystal device, the display of the high-speed responsibility of 1 or less msec is realizable on the impossible wide-field-of-view square according to the liquid crystal equipment of this invention, with sufficient gradation nature with TN component so that clearly from mentioning later. Such a wide-field-of-view angle and the monostable FLC component of high-speed responsibility are driven with active-matrix components, such as TFT, and the color specification which corresponds by the filter element (especially 1 or less msec a color order filter elements, such as a color filter switchable next) can be obtained with sufficient repeatability on the Takashina furniture.
[0016] In order to drive FLC by active matrices, such as TFT, and to make gradation nature discover like the liquid crystal equipment of this invention, at least two drive conditions are needed. That is, it is that gradation nature is controlled by reinforcement of the electrical potential difference which continues being impressed to (1) each pixel between 1 fields, and that the drive approach which reversed applied voltage between the fields or by inter-frame so that a charge might not be accumulated in (2) liquid crystal is applicable.
[0017] In order to realize the drive conditions of these (1) and (2), it is important for the angle of inclination of a liquid crystal molecule to change to a linear mostly to impression field strength, and to have an equivalent angle of inclination by polarity reversals.
[0018] For the implementation, as shown in drawing 13, if a liquid crystal molecule is more strongly stabilized in the one condition of the imagination cone bottom, this invention person the interaction of a liquid crystal molecule and an orientation film interface By the equilibrium of the torque generated by the direct interaction of electric field and the spontaneous polarization of a

liquid crystal molecule, and the elasticity accompanying Splay deformation (breadth deformation) of a liquid crystalline director Angle-of-inclination thetaa of a liquid crystal molecule was continuously controllable by applied voltage, and further, when realizing this structure, it was considered that mono-domain-ization of liquid crystal was also easy.
[0019] Then, liquid crystal molecular orientation found out that it arranged in the orientation processing direction and stable monostable FLC mode could be realized in a mono-domain by this invention person's preparing an FLC constituent with a pitch longer than optical wavelength, and combining with the orientation film ingredient of the low pre tilt expected that orientation restraining force is still larger.
[0020] When not impressing electric field, the array direction of a molecule stabilizes such monostable FLC mode in the orientation processing direction, and according to the polarity, the array direction of the molecule inclines to right and left by electric-field impression. Since this angle of inclination is controllable by field strength, analog gradation is possible for it by the armature-voltage control by TFT. Moreover, dark level can be lowered by mono-domain-ization and a high contrast ratio can be obtained.
[0021] furthermore, this monostable FLC -- for example, -- Taking advantage of the wide-field-of-view angle and the high-speed responsibility which are the description of an FLC display device, the color display which raised the angle-of-visibility property which poses a problem with TN liquid crystal with big-screen-izing, and the responsibility of middle gradation is realizable by combining with the TFT component of 0.7 inches and 103,000 pixel.
[0022] In the liquid crystal display of this invention, it is good to constitute the display device of monochrome combining a monostable FLC component (monostable FLC component which has especially the speed of response of 1 or less msec), and an active-matrix component, and to arrange the filter element (for it to be degree switchable thing to a color order especially at 1 or less msec) between this display device and a display observation post (for example, watcher).
[0023] That is, in TN liquid crystal display component of an active matrix, by what has arranged the color filter, since it became one pixel in the group of three pixels, R (red), G (green), and B (blue), the resolution of the display device was reduced. However, if a display device is made into monochrome as mentioned above and a filter element is changed to color sequential, R, G, and B can be made to serve a double purpose by one pixel, and only the part raises a pixel consistency and can realize high resolution (for example, 3 times over the past).
[0024] Of course, it may be constituted as a display device of a color combining a monostable FLC component, an active-matrix component, and a color filter component.
[0025] The drive approach of the liquid crystal equipment which faces this invention driving the liquid crystal equipment of above-mentioned this invention again, drives a monostable FLC component and changes a filter element by the active-matrix component synchronizing with this drive is also offered.
[0026] In this drive approach, a monostable FLC component can be driven in the response time of 1 or less msec, and the change of a filter element can also be performed by 1 or less msec.
[0027] Moreover, if a filter element is changed into a black condition in the information write-in process (between especially different color specification) over a monostable FLC component, the color remainder can be lost at the time of the change of a color, and the purity balance (grace of image quality) of a color can be raised.
[0028]
[Example] Hereafter, this invention is further explained to a detail about an example.
[0029] A monostable ferroelectric liquid crystal (monostable FLC), monostable FLC usable to the property **** and this invention, and its property are explained.
[0030] 1. In order to check basic actuation in liquid crystal ingredient monostable FLC mode, the **** ferroelectric liquid crystal shown in big drawing 14 of the spontaneous polarization which introduced the fluorine into the chiral section for high-speed responsibility grant as a ferroelectric liquid crystal was compounded newly, and the FLC constituent which added the chiral molecule to the host liquid crystal in which a smectic C phase is shown at a room temperature was prepared.
[0031] As host liquid crystal, the Splay modulus of elasticity (elastic coefficient of breadth) was

high, and the phenyl pyrimidine liquid crystal which blended the liquid crystal layer tilt angle delta and the cone angle theta so that it might become equal was used. The typical physical-properties value of an FLC constituent is shown in the following table 1.

[0032]

表１（ＦＬＣ組成物の物性）

ＦＬＣ組成物	ピッチ長（μm）	自発分極値（nC/cm²）
ＦＬＣ１	２．５	１１．５
ＦＬＣ２	２１．２	２．５
ＦＬＣ３	１０．０	１６．０

[0033] Each of these FLC constituents has a chiral smectic C phase at a room temperature, and the spontaneous polarization value showed 2 - 12 nC/cm2 by addition of several% of chiral liquid crystal (FLC1, FLC2). Generally, although the one where the spontaneous polarization value Ps is larger is accelerated, the response time tau uses coefficient of viscosity eta and the impression field strength E, and it is tau**eta/(Ps-epsilon).
It comes out, and since it is expressed, it is influenced by viscosity.

[0034] On the other hand, it is SmC*. The helical pitch length in a phase is longer than optical wavelength, and in a narrow gap cel, since a spiral comes loose by the interaction with the orientation film, it can attain uniform liquid crystal orientation.

[0035] Furthermore, the ingredient (FLC3) which realized improvement in the speed and large operating temperature was chosen as a practical liquid crystal ingredient.

[0036] 2. The orientation film ingredient and the production orientation film ingredient of a cel had the strong interaction with an FLC constituent, and chose what gives right orientation from the polyimide system orientation film ingredients which give a low pre tilt angle. Specifically, U [by Ube Industries, Ltd.]-varnish etc. was used.

[0037] Production of a homogeneous orientation cel produced the anti-[an parallel cel and] parallel cel depending on how to combine the rubbing processing direction with the transparent electrode on a glass substrate by forming the polyimide orientation film.

[0038] 3. The drive wave for the wave monostable FLC evaluation for monostable evaluation is shown in drawing 15. The wave consisted of a bipolar pulse to which applied-voltage reinforcement increases gradually, and the gradation according to the applied-voltage reinforcement was evaluated. The bipolar pulse was used for not giving an electrochemical damage to a liquid crystal ingredient for the stored charge by the partial electrical-potential-difference impression. Furthermore, insertion of 0V electrical potential difference between bipolar pulses is for measurement of the falling response time at the time of applied-voltage discharge.

[0039] Moreover, the optical system for evaluation of an electro-optics property is shown in drawing 16. The polarizer (the direction of P) which was parallel to the director at the time of monostable of liquid crystal (the orientation processing direction) has been arranged, and the analyzer (the direction of A) has been arranged to it and a perpendicular.

[0040] 4. As a combination active-matrix component with a TFT component, it is for viewfinders. Polly Si-TFT of 0.7 inches and 103,000 pixel was used. a substrate with the color filter of R, G, and B in the common electrode made to counter -- using -- a cel gap -- a catalyst -- formation -- an industrial true glomus is used as a spacer -- 1.2-1.5 It was referred to as mum (refer to drawing 1). Liquid crystal was poured in at isotropic phase temperature under reduced pressure.

[0041] 5. If the cel which carried out liquid crystal impregnation under the result, the organization of the consideration (1) liquid crystal, and the electro-optics property polarization microscope is

observed, the multi-domain organization often seen to SSFLC in an parallel orientation cel is shown, and the electro-optics property is 60microsec by **22v [/micrometer] impression. It has the response time and the memory nature (memory cone angle: 40.5 degrees) of bistability was shown.
[0042] On the other hand, it is parallel to the rubbing processing direction in an anti-parallel cel. The band structure of 2.3-micrometer pitch was shown. It turned out that this stripe is the periodic structure to which the director of liquid crystal inclined about **4 times to the orientation processing direction.
[0043] Since a liquid crystalline director becomes almost parallel to the polarization shaft of a polarizer or an analyzer when the electro-optics property of this anti-parallel cel does not impress electric field, permeability always shows 0 and light transmittance increases with field strength regardless of that polarity by electric-field impression. Although this permeability change is small and high-speed in 0-5V, permeability change is large and a little slow more than 5V. Two steps of switching behavior which has this threshold voltage can be explained to be continuous tilt angle change of a low-battery field by domain switching following this.
[0044] Furthermore, the liquid crystalline director which inclined by electric-field impression showed the monostable nature of returning to the array condition of a basis promptly by removal of electric field. What was restricted by the interaction according [a liquid crystal molecule] to the polyimide orientation film in a return in the original array of the director at the time of electric-field removal is considered to be a factor. However, by this system, the maximum contrast is as small as 46 because of a stripe organization.
[0045] (2) It is a cel in order to improve the improvement contrast of analog gradation nature, and analog gradation nature. Electric-field processing was carried out by alternating current electric-field impression of 700Hz, and 20-50V. It is changeable from a regular stripe organization to a mono-domain organization with rotation of a layer with this electric-field processing. By disappearance of the stripe domain by this formation of a mono-domain, contrast attained 81.
[0046] The electrical-potential-difference dependency of the angle of inclination of the liquid crystalline director in this mono-domain organization is shown in drawing 17. It turns out that an angle of inclination does not wait for threshold voltage, but increases uniformly from a low battery with increase of applied-voltage reinforcement, and it inclines about 22 degrees by about 7 V. Furthermore, the polarity of the applied voltage determines the direction to which a director inclines. Moreover, the response time was also accelerated with about 1 msec rather than the time of a stripe organization.
[0047] Moreover, an example of permeability change of this cel is shown in drawing 18. Light transmittance here was normalized with the permeability at the time of 10V impression. light transmittance changes to a linear mostly to 0V-2V, serves as a loose change after that, and serves as about 1 law more than by 6V-7V. Thus, when the electrical potential difference was not impressed, the liquid crystal molecule realized the list and the condition of having stabilized, in the orientation processing direction by the orientation film interface. Moreover, between the polarizer P which intersected perpendicularly, and Analyzer A, by arranging the direction of orientation of the liquid crystal molecule made monostable in parallel with Polarizer P, light transmittance was controlled by control of the electrical potential difference in a low battery, and analog gradation has been realized.
[0048] In monostable FLC, since birefringence mode is used, in order to obtain the maximum transmission, an apparent tilt angle has 45 desirable degrees, and serves as the almost same transmission as TN mode at this time.
[0049] Furthermore, the liquid crystal ingredient (FLC3) was prepared for improvement in the speed of this device, and expansion of a drive temperature requirement, the orientation film to combine was examined, and the monostable FLC component shown below was realized. However, the tilt angle of the appearance of FLC3 is about 22 degrees.
[0050] (3) It falls with the standup response time of the monostable FLC component (FLC3) which combined the newly found-out monostable FLC constituent and the orientation film with response-time drawing 19 and drawing 20, and the electrical-potential-difference dependency of

the response time and the temperature characteristic are shown. If an electrical-potential-difference dependency is seen at a room temperature, it is accelerated with increase of an electrical potential difference, and the build up time at the time of electrical-potential-difference impression is about 50microsec at 5V. It reached.
[0051] On the other hand, without being dependent on the electrical potential difference currently impressed till then, i.e., the magnitude of the angle of inclination of a director, it is fixed and the response time at the time of electrical-potential-difference removal (falling time amount) is abbreviation. 120microsec It is high-speed.
[0052] Furthermore, the response time starts, falls, both shows the same temperature dependence, and is considered to mainly be based on the effect of viscous temperature dependence. Also in -5 degrees C, the response time of 1 or less msec was still able to be attained. It is thought that it is for returning to the original orientation condition according to generating of anti-electric field by the own spontaneous polarization of FLC which answered by electrical-potential-difference impression that it depends [falling time amount] on an electrical potential difference and is fixed, and especially high-speed.
[0053] (4) The typical angle-of-visibility property of TN liquid crystal device was shown in angle-of-visibility property drawing 21, and the angle-of-visibility property of monostable FLC was shown in drawing 22. Permeability here was measured using the LCD evaluation equipment (parallel light source use) by the Otsuka electronic company, and was standardized with the maximum permeability of zero angle of visibility. Each of these angle-of-visibility properties is permeability change of the vertical direction which omits wide-field-of-view cornification by phase compensation etc.
[0054] According to this, with TN liquid crystal, it is the contrast in a transverse plane. Since it can essentially twist to liquid crystal molecular arrangement or more with 100 although it is large, and it has structure, it changes in the direction in which both black level (0%) and a white level (100%) reduce contrast with change of an angle of visibility. Therefore, the angle-of-visibility dependency of contrast is large. Furthermore, since halftone level, for example, fluctuation at 50%, is very large, in the angle-of-visibility property of the vertical direction, reversal of gradation will arise especially.
[0055] However, although the contrast in the present transverse plane is a maximum of 100 about with a monostable FLC component, the reversal behavior of gradation which fluctuation of the black level accompanying change of an angle of visibility, a white level, and middle gradation level has, and is looked at by TN liquid crystal reflecting that there is no torsion in the array structure of liquid crystal and optical pass being short is not seen by this, but 50 omnidirections or more and a large thing characterize an angle of visibility. [very little]
[0056] (5) The angle-of-visibility property and the response time of monostable FLCD and TN-LCD were summarized in the table 2 of the combination following with a TFT component.
[0057] According to this, by monostable FLCD, it turns out that an active-matrix drive is possible taking advantage of the high-speed responsibility and the wide-field-of-view angle which FLC has. And the point in which combination is possible is characteristic, without changing the conventional TFT component and conventional drive circuit for TN liquid crystal, since driver voltage can drive by the low battery comparatively about 5V and as FLC.
[0058] In contrast, at conventional TN-LCD, it is sum taur+tauf of the response time of a standup and falling. Also in 25 degrees C, it is as late as about 30 msec(s), and image information of 16.7msec(s) of the 1 field cannot fully be reproduced. It is especially set to about 90 msec(s) at 0 degree C, and a tailing phenomenon becomes remarkable further. However, response-time taur+tauf of monostable FLCD At 25 degrees C Since it is 1 or less msec also in 0.2msec and 0 degree C, it is expected that the information on the middle gradation of each field is faithfully reproducible.
[0059]

表2（ＦＬＣとＴＮのデバイス性能の比較）

デバイス特性		単安定ＦＬＣＤｓ	ＴＮ－ＬＣＤｓ
視野角 ＣＲ＞３０	上	＞50°	10°
	下	＞50°	40°
	左	＞50°	45°
	右	＞50°	45°
応答時間 $\tau_r + \tau_f$	＋25℃	0.2msec	約30msec
	０℃	0.8msec	約90msec
モード		ノーマリブラック	ノーマリブラック又はノーマリホワイト

[0060] In the device (this is explained in detail later.) which combined monostable FLCD with the TFT active matrix for the conventional TN liquid crystal (0.7 inches, for 103,000 pixel viewfinders), amelioration of an orientation treatment process and improvement in gap precision attained the uniform liquid crystal stacking tendency of FLC considered to be difficult on level difference structure until now.
[0061] As a driving method, color display of the video rate which has the above-mentioned large angle of visibility was realized by applying the Rhine reversal or field reversal like TN liquid crystal. Also in high-speed migration of the photographic subject in a video camera currently picturized, tailing actually checked few [very] things.
[0062] Electric field as drive mode The normally black mode which serves as dark level when it is off is desirable the point of maintaining electrical neutrality in monostable FLC, and in respect of high contrast.
[0063] Next, a display device is produced combining TFT which is an active-matrix component about monostable FLC based on above-mentioned this invention, and the example which measured the property is explained to a detail.
[0064] Example 1 (production of active-matrix drive mold monostable FLC display device I)
As a component of an active matrix, TFT (Thin Film Transistor: thin film transistor) can be used, for example. Here, R, G, and the TFT component corresponding to B color filter were used.
[0065] The configuration of active-matrix drive mold monostable FLC display device with color filter I is shown in drawing 1 . the N-methyl-2-pyrrolidone solution of U[by Ube Industries, Ltd.]-varnish is applied to TFT6 side on glass substrate 1a by the spin cast method — it calcinates at 200 degree C — polyimide orientation film of 500 A 5a was formed, and rubbing orientation processing was carried out with the roller around which the cloth of an acetate system was wound further. Moreover, the common electrode 4 side formed black Matrix 2 of chromium, the color filter 3, and the transparent electrode (ITO) 4 on glass substrate 1b at this sequence, formed polyimide film 5b in the field of that transparent electrode like the above, and performed rubbing orientation processing.
[0066] Thus, the TFT side panel with the produced orientation film and the color filter side panel were constructed so that the orientation processing direction might serve as anti-parallel by the opposed face, and the glass bead (true glomus: diameter 0.8 - 1.5 mum (catalyst formation industrial company make)) according to the purpose gap length was used as the spacer 7. inside of the sealing compound 8 (adhesives of UV hardening mold (photograph lek: the Sekisui

Chemistry company make)) on which a spacer 7 pastes up a perimeter about 0.3wt% -- by making it distribute, the gap between substrates was controlled, and the injected hole of liquid crystal was secured and the perimeter of a cel was pasted up by the above-mentioned sealing compound.

[0067] Then, the monostable ferroelectric liquid crystal constituent 9 was poured in under reduced pressure in the condition which shows the fluidity of isotropic phase temperature or chiral nematic phase temperature. After cooling slowly and removing the liquid crystal on the glass substrate of the perimeter of an injected hole after liquid crystal impregnation, it closed with UV hardening mold adhesives, and the monostable ferroelectric liquid crystal component was produced. The ferroelectric liquid crystal 9 used here used for the above-mentioned table 1, FLC3 (micrometers [of pitch length / 10], spontaneous polarization 16 nC/cm2) or the constituent 2 (micrometers [of chiral component 2wt% and pitch length / 21.2], spontaneous polarization 2.5 nC/cm2) by Japanese Patent Application No. No. 25131 [three to] by these people, for example, phenyl pyrimidine-liquid-crystal FLC, of a publication.

[0068] With the orientation processing direction, it was parallel, or intersected perpendicularly with each above-mentioned panel, polarizing plates 10a and 10b were formed, and it has arranged to device both sides. The arranged polarizing plate 10 was made to intersect perpendicularly mutually. Furthermore, monostable ferroelectric liquid crystal display device I was completed by arranging a back light 11 to the TFT component side of this panel.

[0069] Example 2 (drive of active-matrix drive mold monostable FLC display device I)

The layout of the component configuration of the active matrix for color filters is shown in drawing 2 . The NTSC signal was changed into each luminance signal of R, G, and B by the decoder, and H for driving TFT to coincidence and the clock pulse for V shift registers were generated from the pulse driver. Each terminal signal in this TFT panel is collectively shown in the following table 3.

[0070] On the occasion of the drive of this display device I, the predetermined signal shown in the following table 3 from each terminal is alternatively inputted into TFT through each gate transistor TR from H shift register, and a switching electrical potential difference is impressed to monostable FLC9 by TFT according to the gate control signal from V shift register (a capacitor for Cs to accumulate 1 frame time of signal charges and COM are the component sections which supply common potential).

[0071]

表３Ａ（ＴＦＴパネルの端子信号）

端子番号	端子記号	電圧	端子説明
1	GREEN	10.5V(DC)	ビデオ信号（G）入力
2	RED	10.5V(DC)	ビデオ信号（R）入力
3	BLUE	10.5V(DC)	ビデオ信号（B）入力
4	HVSS	０V	Ｈドライバ用ＧＮＤ端子
5	TP1	OPEN	テスト端子
6*	HCK1	定格クロック	Ｈシフトレジスタ駆動用クロック入力端子
7*	HCK2	定格クロック	Ｈシフトレジスタ駆動用クロック入力端子
8	HST	定格クロック	Ｈシフトレジスタ駆動用スタートパルス入力端子

[0072]

表３Ｂ（ＴＦＴパネルの端子信号）

端子番号	端子記号	電圧	端子説明
9	HVDD	12V(DC)	Ｈドライバ用電源入力端子
10*	VCK2	定格クロック又は12V(DC)	Ｖシフトレジスタ駆動用クロック入力端子
11*	VCK1		Ｖシフトレジスタ駆動用クロック入力端子
12	VVSS	０V	Ｖドライバ用ＧＮＤ端子
13	VST	12V(DC)	Ｖシフトレジスタ駆動用スタートパルス入力端子
14	VVDD	13.5V(DC)	Ｖドライバ用電源入力端子
15	TP2	OPEN	テスト端子
16	VCOM	６V(DC)	パネルの対向電圧入力端子

* Phase of H and V 180 degrees and a frequency are arbitration.
DC of +4.5 V is impressed to liquid crystal by this electrical-potential-difference impression.

[0073] When image display was carried out with the field frequency of 60Hz, the display which has the large angle of visibility of **50 degrees or more was realizable at 200 or less microseconds and a high speed with this example.
[0074] Example 3 (production of the active-matrix drive mold monostable FLC display device II without a color filter)
As an active-matrix component, TFT (Thin Film Transistor: thin film transistor) can be used, for example. Here, the TFT component for monochrome was used.
[0075] The configuration of the active-matrix drive mold monostable FLC display device II of color filter loess is shown in drawing 3 . the N-methyl-2-pyrrolidone solution of U[by Ube Industries, Ltd.]-varnish is applied to the TFT6 side of glass substrate 1a by the spin cast method -- it calcinates at 200 degree C -- polyimide orientation film of 500 A 5a was formed, and rubbing orientation processing was carried out with the roller around which the cloth of an acetate system was wound further. Moreover, the common electrode 4 side formed black Matrix 2 of chromium, and a transparent electrode (ITO) 4 on glass substrate 1b at this sequence, formed polyimide film 5b in that transparent electrode side 4 similarly, and performed rubbing orientation processing.
[0076] Thus, the TFT side panel with the produced orientation film and the color filter side panel were constructed so that the orientation processing direction might serve as anti-parallel by the opposed face, and the glass bead (true glomus: diameter 0.8 - 1.5 mum (catalyst formation industrial company make)) according to the purpose gap length was used as the spacer 7. inside of the sealing compound 8 (adhesives of UV hardening mold (photograph lek: the Sekisui Chemistry company make)) on which a spacer 7 pastes up a perimeter about 0.3wt% -- by making it distribute, the gap between substrates was controlled, and the injected hole of liquid crystal was secured and the perimeter of a cel was pasted up by the above-mentioned sealing compound.
[0077] Then, the monostable ferroelectric liquid crystal constituent 9 was poured in under reduced pressure in the condition which shows the fluidity of isotropic phase temperature or chiral nematic phase temperature. After cooling slowly and removing the liquid crystal on the glass substrate of the perimeter of an injected hole after liquid crystal impregnation, it closed with UV hardening mold adhesives, and the monostable ferroelectric liquid crystal component was produced. The ferroelectric liquid crystal 9 used here used the same constituent as Example 1.
[0078] With the orientation processing direction, it was parallel, or intersected perpendicularly with each above-mentioned panel, polarizing plates 10a and 10b were formed, and it has arranged to device both sides. The arranged polarizing plate 10 was made to intersect perpendicularly mutually. Furthermore, the monostable ferroelectric liquid crystal display device II of color filter loess was completed by arranging a back light 11 to the TFT component side of this panel (however, although a color filter is prepared apart from an FLC component, refer to drawing 12 of :postscript which carried out the illustration abbreviation here for it).
[0079] Example 4 (drive of the active-matrix drive mold monostable FLC display device II)
The layout of the component configuration of the active matrix for color filter loess (monochrome) is shown in drawing 4 . The NTSC signal was changed into R, G, and B signal by the decoder, and H for driving TFT to coincidence and the clock pulse for V shift registers were generated from the pulse driver. Although each terminal signal in this TFT panel was shown in the above-mentioned table 3, in this example, each luminance signal of each R, and G and B was inputted from the common terminal of No. 3.
[0080] Also in this example, when image display was carried out with the field frequency of 60Hz, the display which has the large angle of visibility of **50 degrees or more was realizable with 200 or less microseconds and a high speed. And since each signal of R, G, and B can be inputted from a common terminal by color filter loess, as compared with TFT for color filters, the effective number of pixels can be increased 3 times, and high-resolution-izing is possible.
[0081] Example 5 (color order the production approach of the liquid crystal filter for degree change)
The configuration of a cel is as being shown in drawing 5 . That is, transparent electrodes 4a and

4b (ITO ofohms [100] / **) were attached on transparence glass substrate 1a and 1b, and the method vacuum evaporationo film 5a and 5b of slanting of SiO was further formed as liquid crystal orientation film on it. As the formation approach of this method vacuum evaporationo film of SiO slanting, in the vacuum evaporation system, the substrate was arranged on the vertical from the source of SiO vacuum evaporationo, and the angle which the line of a vertical and a substrate normal make was installed as 85 degrees. It is substrate temperature about SiO. The vacuum deposition back, and 300 degree C and baking of 1 hour were performed at 170 degrees C.

[0082] Thus, the produced substrate with the orientation film was constructed so that the orientation processing direction might serve as anti-parallel by the opposed face, and the glass bead (true glomus: diameter 0.8 - 3.0 mum (catalyst formation industrial company make)).. according to the purpose gap length was used as the spacer 7. inside of the sealing compound 8 (adhesives of UV hardening mold (photograph lek: the Sekisui Chemistry company make)) on which a spacer 7 pastes up a perimeter with the magnitude of a transparence substrate in the case of a small area about 0.3wt% -- the gap between substrates was controlled by making it distribute. Furthermore, when substrate area is large, it is mean density on a substrate about the above-mentioned truth glomus. 100 piece/mm2 After sprinkling, the gap was taken, the injected hole of liquid crystal was secured and the perimeter of a cel was pasted up by the above-mentioned sealing compound.

[0083] Then, the ferroelectric liquid crystal 9 (for example, CS[by Chisso / Corp. / Corp.]-1014) was poured in under reduced pressure in the condition which shows the fluidity of isotropic phase temperature or chiral nematic phase temperature. After cooling slowly and removing the liquid crystal on the glass substrate of the perimeter of an injected hole after liquid crystal impregnation, it closed with the adhesives of an epoxy system and the ferroelectric liquid crystal component was produced.

[0084] Although the Chisso [Corp.] Corp. make, the Merck [Co.]& Co., Inc. make, the product made from BDH, other well-known ferroelectric liquid crystal compounds, or a constituent with un-chiral liquid crystal is also possible for the ferroelectric liquid crystal to be used, the limit does not exist, and does not need a limit of the phase sequence, either, but the thing which is the need is taking a chiral smectic liquid crystal phase in operating temperature limits. Furthermore, if the switching speed except chiral smectic liquid crystal is high-speed, the smectic A phase which shows antiferroelectricity liquid crystal (AFLC) and an electroclinic effect is also applicable, for example.

[0085] The electro-optics property of the liquid crystal filter for a color sequential change by this example is as being shown in the following table 4.

[0086]

[Table 1]

表4（ＦＬＣ素子の電気光学特性）

ＦＬＣサンプル	ｷﾞｬｯﾌﾟ (μm)	ﾘﾀﾃﾞｰｼｮﾝ (nm)	見かけのコーン角 (deg)	方形波			パルス駆動			
				印加電圧	応答時間		印加電圧	ﾊﾟﾙｽ幅	応答時間	
					10-90%T	90-10%T			10-90%T	90-10%T
CS-1014	2.10	263.7	46.5	30Hz, ±15V	118 μs	100 μs	±20V	425 μs	61μs	56μs
							±30V	254 μs	40μs	36μs

[0087] According to this, it turns out that this liquid crystal filter (FLC liquid crystal device) shows the phase contrast of the abbreviation one half of use optical wavelength, and it has the spec. which can rotate the plane of polarization of incident light about 90 degrees.

[0088] Example 6 (color order drive wave of the liquid crystal filter for degree change)
As a method of driving the ferroelectric liquid crystal component of Example 5, the method of driving the conventional general FLC is applicable. An example of a drive wave which changes a switch condition to drawing 6 - drawing 9 once within one frame is shown..

[0089] Drawing 6 is a square wave drive. It is the approach of maintaining electrical neutrality conditions by one frame, and although the time amount to which DC electrical potential

difference is impressed compared with the pulse drive is long, when the insulation of a component is high, it is the reliable driving method. It can be used for AFLC besides FLC, and electroclinic effect mold smectic A.
[0090] Drawing 7 is the pulse drive with a reset pulse, it is the approach of adding a reset pulse and maintaining the electrical neutrality conditions in the field just before writing, and a prolonged dc component is hard to be impressed to liquid crystal.
[0091] Drawing 8 is the pulse drive without a reset pulse, and is the approach of maintaining the electrical neutrality conditions within one frame.
[0092] Drawing 9 is the pulse drive without a reset pulse, and is the approach a liquid crystal ingredient system with few memory effects can also hold a switch condition, and maintains the electrical neutrality conditions within one frame at coincidence by applied-voltage maintenance after pulse impression. It can be used also for AFLC besides FLC.
[0093] The switching characteristic by the above-mentioned drive wave was shown in the above-mentioned table 4. It starts (10-90%T), and falling (90-10%T) all shows the high-speed response of microsecond order, and sufficient response in 1 field is guaranteed.
[0094] Example 7 (color order configuration of a drive [degree] mold monostable FLC display device)
By combining the FLC component (switching device) and color polarizing plate (color filter) of Example 5 (or example 3), a switchable component is [the color of the transmitted light] realizable for R, G, and B. The configuration of a color sequential drive monostable FLC display device is shown in drawing 10.
[0095] That is, FLC component 12a (FLC1) which can rotate 90 degrees of plane of polarization at high speed in the front face of polarizing plate 10B (P1) of the monochrome type active-matrix drive mold monostable FLC display device of drawing 3 produced in Example 3, the color polarizing plate 13 (P2), FLC component 12b (FLC2), and the color polarizing plate 14 (P3) have been arranged in this order. The direction of the switch condition 1 of the abnormality optical axis of FLC1 and FLC2 has been arranged to a rectangular cross or parallel to the light transmission easy shaft of polarizing plate 10b (P1), and B light transmission easy shaft of the color polarizing plate P2 and R light transmission easy shaft of the color polarizing plate P3 have been further arranged in parallel to the light transmission easy shaft of a polarizing plate P1.
[0096] In the state of [2] the switch condition 1 and a switch, about 45 degrees of abnormality opticals axis incline, and it is the RETADESHON. By being referred to as 270nm For example, in order to carry out incidence of R and G which passed along the polarizing plate P1, and the B light in parallel with B light transmission easy shaft of the color polarizing plate P2 without receiving rotatory polarization when the switch condition of FLC1 is 15 (switch condition 1), it becomes only B light to penetrate the color polarizing plate P2.
[0097] If the switch condition of FLC2 is 15 at this time, in order to carry out incidence of the B light similarly in parallel with R light transmission easy shaft of the color polarizing plate P3, without receiving rotatory polarization, B light cannot be penetrated but serves as black. That is, black is always realizable irrespective of the gradation in a monostable FLC component in this case.
[0098] On the other hand, when the switch condition of FLC1 of R and G which passed along the polarizing plate P1, and B light is 16 (switch condition 2), in order for 90 degrees of plane of polarization to rotate and to carry out incidence in parallel with R of the color polarizing plate P2, and G light transmission easy shaft, it becomes only R and G light to penetrate the color polarizing plate P2.
[0099] If the switch condition of FLC2 is 15 at this time, in order to carry out incidence of R and the G light in parallel with G of the color polarizing plate P3, and B light transmission easy shaft, without receiving rotatory polarization, R light cannot be penetrated but penetrates only G. That is, the green display according to the gradation in a monostable FLC component is realizable in this case.
[0100] Moreover, if the switch condition of FLC2 is 16 at this time, since R and 90 degrees of G light plane of polarization will rotate and it will carry out incidence similarly in parallel with R light transmission easy shaft of the color polarizing plate P3, G light cannot be penetrated but

penetrates only R. That is, a display of the red according to the gradation in a monostable FLC component is realizable in this case.
[0101] The switch condition of FLC1 and FLC2 and the class of transmitted light were summarized into the following table 5.
[0102]
表5（ＦＬＣ１とＦＬＣ２のスイッチ状態と透過光の種類）

ＦＬＣ１	ＦＬＣ２	表示色	階調性
スイッチ状態１	スイッチ状態１	黒	なし
スイッチ状態１	スイッチ状態２（90° 回転）	青	あり
スイッチ状態２（90° 回転）	スイッチ状態１	緑	あり
スイッチ状態２（90° 回転）	スイッチ状態２（90° 回転）	赤	あり

[0103] Thus, the change of a color was possible by the combination of the switch condition of the FLC components FLC1 and FLC2.
[0104] Example 8 (color order the driving [degree] method)
The method of driving the panel produced in Example 5 is explained. The configuration of the drive circuit of a color sequential drive mold monostable FLC display device is shown in drawing 11.
[0105] Although an input signal does not ask NTSC, Y/C, and an RGB code, it is made into R, G, and B signal by the decoder, and incorporates a part for the 1 field to a field memory 1. Before incorporating the next field, it transmits to the following buffer memory (field memory) 2. Furthermore, while having incorporated the next field, a full color display device is realizable by making it synchronize with a shift register driving pulse from a pulse driver, inputting R signal, G signal, and B signal into the signal terminal of No. 3 of a monostable FLC component from buffer memory 2, synchronizing coincidence with it and performing a color sequential change to it.
[0106] The timing table of a drive of this color sequential drive mold monostable FLC display device is shown in drawing 12. It is characteristic to have changed the color filter into the black condition and to have prevented degradation of image quality in the write-in process to monostable FLC, here, in the approach (for the square wave of drawing 6 to be used) of turning on R, G, and B once each in 1 field.
[0107] Usually, with NTSC system, the 1 field is 1/60. It is a second and each color includes the time of a write-in process and a hold. It must complete in 16.67 seconds. However, the display property will produce the so-called color breakup (each color of R, G, and B separates and is expressed as the edge of an image.) only by writing in R, G, and B once each in 1 field.
[0108] Therefore, color breakup is [R, G, and B] reducible 2 times (R/G/B/R/G/B) or by repeating 3 times (R/G/B/R/G/B/R/G/B). However, since, as for each switch condition, only the period for 1 / 540 seconds (1.85msec) is given at 1 / 360 seconds, and 3 times of cases, as for each switch condition, rapidity with the remarkable change rate of a color filter is required of 1 / 180 seconds, and 2 times of cases at 1 time of a case, as for each switch condition.
[0109] Then, when it was the above-mentioned FLC (ferroelectric liquid crystal) as a liquid crystal device, as it was shown in above-mentioned Table 4 and above-mentioned drawing 19, it is build up time. Since 0.1 or less msecs were attained, high-speed sufficient switching corresponding to the above-mentioned change rate was attained.

[0110] As mentioned above, although this invention was explained about the example, the example mentioned above can transform it further based on the technical thought of this invention.
[0111] for example, various the quality of the material of each component of a liquid crystal device, structure, configurations, the approaches including the class of liquid crystal of assembling, etc. can be boiled and changed. As a display, if at least one side of the substrate (for example, above-mentioned 1a, 1b) is optically transparent, it is good.
[0112] In addition, although the example mentioned above explained the suitable liquid crystal device for a display device, it is desirable at the point that gradation nature (halftone) is realizable in especially a display device. However, this invention can apply not only a display device but a liquid crystal device to the display screen of a filter, or a shutter and OA equipment, a screen, the phase control component for wobbling, etc.
[0113]
[Function and Effect of the Invention] Since according to the liquid crystal device of this invention a monostable ferroelectric liquid crystal component (monostable FLC component), active-matrix components, such as TFT which drives this liquid crystal device, and a filter element are combined as mentioned above, the display of the high-speed responsibility of 1 or less msec is realizable on the impossible wide-field-of-view square with sufficient gradation nature by using the monostable FLC component as a liquid crystal device with TN component.
[0114] Such a wide-field-of-view angle and the monostable FLC component of high-speed responsibility are driven with active-matrix components, such as TFT, and the color specification which corresponds by the filter element (especially 1 or less msec a color order filter elements, such as a color filter switchable next) can be obtained with sufficient repeatability on the Takashina furniture.

[Translation done.]

* NOTICES *

TECHNICAL FIELD

[Industrial Application] This invention relates to liquid crystal equipment (for example, display using the ferroelectric liquid crystal component with which the substrate of the pair which prepared a transparent electrode and the orientation film in this order keeps a predetermined gap, and opposite arrangement is carried out and which is matched with the ferroelectric liquid crystal in said gap), and its drive approach.

[Translation done.]

PRIOR ART

[Description of the Prior Art] As for a liquid crystal display component, the need as a flat-panel display is being extended from the advantage that it can drive, with a low power with a thin shape. Especially, with the twist nematic liquid crystal display component (TN-LCD) of an active-matrix drive, the image quality is improving by leaps and bounds in recent years.
[0003] However, since TN liquid crystal has torsion of molecular orientation with big-screen-izing of a display, after-images, such as straitness of an angle of visibility, reversal of gradation, and tailing produced since the speed of response is still slower, pose a problem.
[0004] Although technique, such as cancellation of the twist structure by adoption of a phase compensation film and the device of the orientation film, is being developed about expansion of an angle of visibility, it is still inadequate. Moreover, even if it makes driver voltage high, of course by the driver voltage of the present TFT (thin film transistor) about a speed of response, since the response time of a return in the twist structure at the time of electrolysis removal cannot be shortened to dozens of or less mses, by Nor Marie White's display device, its response to white from black is very slow, and it brings a result in which especially after-images, such as tailing, are conspicuous.
[0005] As this wide-field-of-view angle and a liquid crystal ingredient which realizes a high-speed response to coincidence, a ferroelectric liquid crystal (ferroelectric liquidcrystals (FLCs)) can be considered. By the passive matrix drive, on the 1000 or more number of scanning lines and a wide-field-of-view square, a surface stability mold ferroelectric liquid crystal display device (SSFLCD) is expected by about 1000 times as much high-speed responsibility as TN liquid crystal and memory nature as a technique of realizing a cheap big screen flat-panel display, and is examined.
[0006] In such a ferroelectric liquid crystal (further liquid crystal of antiferroelectricity liquid crystal) The switching behavior of the liquid crystalline director by electrolysis impression moves on a cone with an imagination liquid crystal molecule according to the Minabe-gold stone mode indicated by the liquid crystal lexicon p150 (Baifukan). Furthermore, in the smectic A liquid crystal (liquid crystal lexicon p145 (Baifukan)) which has an electroclinic effect, even when the software mode indicated by the liquid crystal lexicon p119 (Baifukan) is used, it has the cone angle of a proper in each liquid crystal constituent similar to a cone angle.
[0007] That is, the cone model of the liquid crystal inserted into inter-electrode as shown in drawing 23 is considered. The projection to the glass substrate to which the transparent electrode of cone angle thetar, a call, and this cone angle was attached in the aperture angle of a cone is called apparent cone angle thetaa. What is necessary is optically, just to consider cone angle thetaa of this appearance. The angle which the liquid crystalline director in two switch conditions makes about measurement of a cone angle here is measured, and it specifically asked for the liquid crystal cell under the polarization microscope with which the polarizer intersected perpendicularly from the angle of rotation of the stage in an extinction position (location which rotates and becomes dark).
[0008] However, in the conventional FLC, especially SSFLCD, although high-speed responsibility is shown for the strong interaction of the permanent dipole of an FLC molecule, and electric field, as shown in drawing 23, a liquid crystal molecule is bistability-ized by the restraint from an

orientation film molecule.
[0009] Therefore, angle-of-inclination thetaa could be continuously controlled by switching between 2 conditions of this isoenergetic for the steep threshold property over electrical-potential-difference impression, and ** and a gradation display were difficult.
[0010] As gradation NOT-AND operation notation in the passive drive of SSFLCD, digital approaches, such as the area gradation method for having divided the time integration method and one drawing, are proposed. However, by this digital method, it has come to obtain the still sufficient number of gradation.
[0011] The gradation notation which does not use bistability memory nature is also proposed by on the other hand recently combining the active-matrix component and FLC which are used in TN liquid crystal device.
[0012] For example, gradation control is carried out, when the pitch length in a chiral smectic C phase dispels the distorted helical structure by electric-field impression using FLC shorter than optical wavelength and controls the average inclination of a liquid crystalline director. However, since liquid crystal orientation has stripes-like organization, the contrast is low.

[Translation done.]

EFFECT OF THE INVENTION

[Function and Effect of the Invention] Since according to the liquid crystal device of this invention a monostable ferroelectric liquid crystal component (monostable FLC component), active-matrix components, such as TFT which drives this liquid crystal device, and a filter element are combined as mentioned above, the display of the high-speed responsibility of 1 or less msec is realizable on the impossible wide-field-of-view square with sufficient gradation nature by using the monostable FLC component as a liquid crystal device with TN component.
[0114] Such a wide-field-of-view angle and the monostable FLC component of high-speed responsibility are driven with active-matrix components, such as TFT, and the color specification which corresponds by the filter element (especially 1 or less msec a color order filter elements, such as a color filter switchable next) can be obtained with sufficient repeatability on the Takashina furniture.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] The purpose of this invention has high-speed responsibility on a wide-field-of-view square, enables a gradation display and is to offer the liquid crystal equipment (especially full color display) which resolution may also raise further, and its drive approach.

[Translation done.]

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MEANS

[Means for Solving the Problem] That is, this invention relates to the liquid crystal equipment (LCD) which combined a monostable ferroelectric liquid crystal component (monostable FLC component), active-matrix components, such as TFT which drives this liquid crystal device, and a filter element.
[0015] Since the monostable FLC component is used as a liquid crystal device, the display of the high-speed responsibility of 1 or less msec is realizable on the impossible wide-field-of-view square according to the liquid crystal equipment of this invention, with sufficient gradation nature with TN component so that clearly from mentioning later. Such a wide-field-of-view angle and the monostable FLC component of high-speed responsibility are driven with active-matrix components, such as TFT, and the color specification which corresponds by the filter element (especially 1 or less msec a color order filter elements, such as a color filter switchable next) can be obtained with sufficient repeatability on the Takashina furniture.
[0016] In order to drive FLC by active matrices, such as TFT, and to make gradation nature discover like the liquid crystal equipment of this invention, at least two drive conditions are needed. That is, it is that gradation nature is controlled by reinforcement of the electrical potential difference which continues being impressed to (1) each pixel between 1 fields, and that the drive approach which reversed applied voltage between the fields or by inter-frame so that a charge might not be accumulated in (2) liquid crystal is applicable.
[0017] In order to realize the drive conditions of these (1) and (2), it is important for the angle of inclination of a liquid crystal molecule to change to a linear mostly to impression field strength, and to have an equivalent angle of inclination by polarity reversals.
[0018] For the implementation, as shown in drawing 13, if a liquid crystal molecule is more strongly stabilized in the one condition of the imagination cone bottom, this invention person the interaction of a liquid crystal molecule and an orientation film interface By the equilibrium of the torque generated by the direct interaction of electric field and the spontaneous polarization of a liquid crystal molecule, and the elasticity accompanying Splay deformation (breadth deformation) of a liquid crystalline director Angle-of-inclination thetaa of a liquid crystal molecule was continuously controllable by applied voltage, and further, when realizing this structure, it was considered that mono-domain-ization of liquid crystal was also easy.
[0019] Then, liquid crystal molecular orientation found out that it arranged in the orientation processing direction and stable monostable FLC mode could be realized in a mono-domain by this invention person's preparing an FLC constituent with a pitch longer than optical wavelength, and combining with the orientation film ingredient of the low pre tilt expected that orientation restraining force is still larger.
[0020] When not impressing electric field, the array direction of a molecule stabilizes such monostable FLC mode in the orientation processing direction, and according to the polarity, the array direction of the molecule inclines to right and left by electric-field impression. Since this angle of inclination is controllable by field strength, analog gradation is possible for it by the armature-voltage control by TFT. Moreover, dark level can be lowered by mono-domain-ization and a high contrast ratio can be obtained.
[0021] furthermore, this monostable FLC -- for example, -- Taking advantage of the wide-field-

of-view angle and the high-speed responsibility which are the description of an FLC display device, the color display which raised the angle-of-visibility property which poses a problem with TN liquid crystal with big-screen-izing, and the responsibility of middle gradation is realizable by combining with the TFT component of 0.7 inches and 103,000 pixel.

[0022] In the liquid crystal display of this invention, it is good to constitute the display device of monochrome combining a monostable FLC component (monostable FLC component which has especially the speed of response of 1 or less msec), and an active-matrix component, and to arrange the filter element (for it to be degree switchable thing to a color order especially at 1 or less msec) between this display device and a display observation post (for example, watcher).

[0023] That is, in TN liquid crystal display component of an active matrix, by what has arranged the color filter, since it became one pixel in the group of three pixels, R (red), G (green), and B (blue), the resolution of the display device was reduced. However, if a display device is made into monochrome as mentioned above and a filter element is changed to color sequential, R, G, and B can be made to serve a double purpose by one pixel, and only the part raises a pixel consistency and can realize high resolution (for example, 3 times over the past).

[0024] Of course, it may be constituted as a display device of a color combining a monostable FLC component, an active-matrix component, and a color filter component.

[0025] The drive approach of the liquid crystal equipment which faces this invention driving the liquid crystal equipment of above-mentioned this invention again, drives a monostable FLC component and changes a filter element by the active-matrix component synchronizing with this drive is also offered.

[0026] In this drive approach, a monostable FLC component can be driven in the response time of 1 or less msec, and the change of a filter element can also be performed by 1 or less msec.

[0027] Moreover, if a filter element is changed into a black condition in the information write-in process (between especially different color specification) over a monostable FLC component, the color remainder can be lost at the time of the change of a color, and the purity balance (grace of image quality) of a color can be raised.

[Translation done.]

EXAMPLE

[Example] Hereafter, this invention is further explained to a detail about an example.
[0029] A monostable ferroelectric liquid crystal (monostable FLC), monostable FLC usable to the property **** and this invention, and its property are explained.
[0030] 1. In order to check basic actuation in liquid crystal ingredient monostable FLC mode, the **** ferroelectric liquid crystal shown in big drawing 14 of the spontaneous polarization which introduced the fluorine into the chiral section for high-speed responsibility grant as a ferroelectric liquid crystal was compounded newly, and the FLC constituent which added the chiral molecule to the host liquid crystal in which a smectic C phase is shown at a room temperature was prepared.
[0031] As host liquid crystal, the Splay modulus of elasticity (elastic coefficient of breadth) was high, and the phenyl pyrimidine liquid crystal which blended the liquid crystal layer tilt angle delta and the cone angle theta so that it might become equal was used. The typical physical-properties value of an FLC constituent is shown in the following table 1.
[0032]

表１（ＦＬＣ組成物の物性）

ＦＬＣ組成物	ピッチ長（μｍ）	自発分極値（nC/cm²）
ＦＬＣ１	２．５	１１．５
ＦＬＣ２	２１．２	２．５
ＦＬＣ３	１０．０	１６．０

[0033] Each of these FLC constituents has a chiral smectic C phase at a room temperature, and the spontaneous polarization value showed 2 - 12 nC/cm2 by addition of several% of chiral liquid crystal (FLC1, FLC2). Generally, although the one where the spontaneous polarization value Ps is larger is accelerated, the response time tau uses coefficient of viscosity eta and the impression field strength E, and it is tau**eta/(Ps-epsilon).
It comes out, and since it is expressed, it is influenced by viscosity.
[0034] On the other hand, it is SmC*. The helical pitch length in a phase is longer than optical wavelength, and in a narrow gap cel, since a spiral comes loose by the interaction with the orientation film, it can attain uniform liquid crystal orientation.
[0035] Furthermore, the ingredient (FLC3) which realized improvement in the speed and large operating temperature was chosen as a practical liquid crystal ingredient.
[0036] 2. The orientation film ingredient and the production orientation film ingredient of a cel had the strong interaction with an FLC constituent, and chose what gives right orientation from the polyimide system orientation film ingredients which give a low pre tilt angle. Specifically, U [by Ube Industries, Ltd.]-varnish etc. was used.

[0037] Production of a homogeneous orientation cel produced the anti-[an parallel cel and] parallel cel depending on how to combine the rubbing processing direction with the transparent electrode on a glass substrate by forming the polyimide orientation film.
[0038] 3. The drive wave for the wave monostable FLC evaluation for monostable evaluation is shown in drawing 15. The wave consisted of a bipolar pulse to which applied-voltage reinforcement increases gradually, and the gradation according to the applied-voltage reinforcement was evaluated. The bipolar pulse was used for not giving an electrochemical damage to a liquid crystal ingredient for the stored charge by the partial electrical-potential-difference impression. Furthermore, insertion of 0V electrical potential difference between bipolar pulses is for measurement of the falling response time at the time of applied-voltage discharge.
[0039] Moreover, the optical system for evaluation of an electro-optics property is shown in drawing 16. The polarizer (the direction of P) which was parallel to the director at the time of monostable of liquid crystal (the orientation processing direction) has been arranged, and the analyzer (the direction of A) has been arranged to it and a perpendicular.
[0040] 4. As a combination active-matrix component with a TFT component, it is for viewfinders. Polly Si-TFT of 0.7 inches and 103,000 pixel was used. a substrate with the color filter of R, G, and B in the common electrode made to counter — using — a cel gap — a catalyst — formation — an industrial true glomus is used as a spacer — 1.2-1.5 It was referred to as mum (refer to drawing 1). Liquid crystal was poured in at isotropic phase temperature under reduced pressure.
[0041] 5. If the cel which carried out liquid crystal impregnation under the result, the organization of the consideration (1) liquid crystal, and the electro-optics property polarization microscope is observed, the multi-domain organization often seen to SSFLC in an parallel orientation cel is shown, and the electro-optics property is 60microsec by **22v [/micrometer] impression. It has the response time and the memory nature (memory cone angle: 40.5 degrees) of bistability was shown.
[0042] On the other hand, it is parallel to the rubbing processing direction in an anti-parallel cel. The band structure of 2.3-micrometer pitch was shown. It turned out that this stripe is the periodic structure to which the director of liquid crystal inclined about **4 times to the orientation processing direction.
[0043] Since a liquid crystalline director becomes almost parallel to the polarization shaft of a polarizer or an analyzer when the electro-optics property of this anti-parallel cel does not impress electric field, permeability always shows 0 and light transmittance increases with field strength regardless of that polarity by electric-field impression. Although this permeability change is small and high-speed in 0-5V, permeability change is large and a little slow more than 5V. Two steps of switching behavior which has this threshold voltage can be explained to be continuous tilt angle change of a low-battery field by domain switching following this.
[0044] Furthermore, the liquid crystalline director which inclined by electric-field impression showed the monostable nature of returning to the array condition of a basis promptly by removal of electric field. What was restricted by the interaction according [a liquid crystal molecule] to the polyimide orientation film in a return in the original array of the director at the time of electric-field removal is considered to be a factor. However, by this system, the maximum contrast is as small as 46 because of a stripe organization.
[0045] (2) It is a cel in order to improve the improvement contrast of analog gradation nature, and analog gradation nature. Electric-field processing was carried out by alternating current electric-field impression of 700Hz, and 20-50V. It is changeable from a regular stripe organization to a mono-domain organization with rotation of a layer with this electric-field processing. By disappearance of the stripe domain by this formation of a mono-domain, contrast attained 81.
[0046] The electrical-potential-difference dependency of the angle of inclination of the liquid crystalline director in this mono-domain organization is shown in drawing 17. It turns out that an angle of inclination does not wait for threshold voltage, but increases uniformly from a low battery with increase of applied-voltage reinforcement, and it inclines about 22 degrees by about

7 V. Furthermore, the polarity of the applied voltage determines the direction to which a director inclines. Moreover, the response time was also accelerated with about 1 msec rather than the time of a stripe organization.
[0047] Moreover, an example of permeability change of this cel is shown in drawing 18. Light transmittance here was normalized with the permeability at the time of 10V impression. light transmittance changes to a linear mostly to 0V-2V, serves as a loose change after that, and serves as about 1 law more than by 6V-7V. Thus, when the electrical potential difference was not impressed, the liquid crystal molecule realized the list and the condition of having stabilized, in the orientation processing direction by the orientation film interface. Moreover, between the polarizer P which intersected perpendicularly, and Analyzer A, by arranging the direction of orientation of the liquid crystal molecule made monostable in parallel with Polarizer P, light transmittance was controlled by control of the electrical potential difference in a low battery, and analog gradation has been realized.
[0048] In monostable FLC, since birefringence mode is used, in order to obtain the maximum transmission, an apparent tilt angle has 45 desirable degrees, and serves as the almost same transmission as TN mode at this time.
[0049] Furthermore, the liquid crystal ingredient (FLC3) was prepared for improvement in the speed of this device, and expansion of a drive temperature requirement, the orientation film to combine was examined, and the monostable FLC component shown below was realized. However, the tilt angle of the appearance of FLC3 is about 22 degrees.
[0050] (3) It falls with the standup response time of the monostable FLC component (FLC3) which combined the newly found-out monostable FLC constituent and the orientation film with response-time drawing 19 and drawing 20, and the electrical-potential-difference dependency of the response time and the temperature characteristic are shown. If an electrical-potential-difference dependency is seen at a room temperature, it is accelerated with increase of an electrical potential difference, and the build up time at the time of electrical-potential-difference impression is about 50microsec at 5V. It reached.
[0051] On the other hand, without being dependent on the electrical potential difference currently impressed till then, i.e., the magnitude of the angle of inclination of a director, it is fixed and the response time at the time of electrical-potential-difference removal (falling time amount) is abbreviation. 120microsec It is high-speed.
[0052] Furthermore, the response time starts, falls, both shows the same temperature dependence, and is considered to mainly be based on the effect of viscous temperature dependence. Also in -5 degrees C, the response time of 1 or less msec was still able to be attained. It is thought that it is for returning to the original orientation condition according to generating of anti-electric field by the own spontaneous polarization of FLC which answered by electrical-potential-difference impression that it depends [falling time amount] on an electrical potential difference and is fixed, and especially high-speed.
[0053] (4) The typical angle-of-visibility property of TN liquid crystal device was shown in angle-of-visibility property drawing 21, and the angle-of-visibility property of monostable FLC was shown in drawing 22. Permeability here was measured using the LCD evaluation equipment (parallel light source use) by the Otsuka electronic company, and was standardized with the maximum permeability of zero angle of visibility. Each of these angle-of-visibility properties is permeability change of the vertical direction which omits wide-field-of-view cornification by phase compensation etc.
[0054] According to this, with TN liquid crystal, it is the contrast in a transverse plane. Since it can essentially twist to liquid crystal molecular arrangement or more with 100 although it is large, and it has structure, it changes in the direction in which both black level (0%) and a white level (100%) reduce contrast with change of an angle of visibility. Therefore, the angle-of-visibility dependency of contrast is large. Furthermore, since halftone level, for example, fluctuation at 50%, is very large, in the angle-of-visibility property of the vertical direction, reversal of gradation will arise especially.
[0055] However, although the contrast in the present transverse plane is a maximum of 100 about with a monostable FLC component, the reversal behavior of gradation which fluctuation of

the black level accompanying change of an angle of visibility, a white level, and middle gradation level has, and is looked at by TN liquid crystal reflecting that there is no torsion in the array structure of liquid crystal and optical pass being short is not seen by this, but 50 omnidirections or more and a large thing characterize an angle of visibility. [very little]
[0056] (5) The angle-of-visibility property and the response time of monostable FLCD and TN-LCD were summarized in the table 2 of the combination following with a TFT component.
[0057] According to this, by monostable FLCD, it turns out that an active-matrix drive is possible taking advantage of the high-speed responsibility and the wide-field-of-view angle which FLC has. And the point in which combination is possible is characteristic, without changing the conventional TFT component and conventional drive circuit for TN liquid crystal, since driver voltage can drive by the low battery comparatively about 5V and as FLC.
[0058] In contrast, at conventional TN-LCD, it is sum taur+tauf of the response time of a standup and falling. Also in 25 degrees C, it is as late as about 30 msec(s), and image information of 16.7msec(s) of the 1 field cannot fully be reproduced. It is especially set to about 90 msec(s) at 0 degree C, and a tailing phenomenon becomes remarkable further. However, response-time taur+tauf of monostable FLCD At 25 degrees C Since it is 1 or less msec also in 0.2msec and 0 degree C, it is expected that the information on the middle gradation of each field is faithfully reproducible.
[0059]

表２（ＦＬＣとＴＮのデバイス性能の比較）

デバイス特性		単安定ＦＬＣＤｓ	ＴＮ－ＬＣＤｓ
視野角 ＣＲ＞３０	上	>50°	10°
	下	>50°	40°
	左	>50°	45°
	右	>50°	45°
応答時間 $\tau_r + \tau_f$	+25℃	0.2msec	約30msec
	0℃	0.8msec	約90msec
モード		ノーマリブラック	ノーマリブラック又は ノーマリホワイト

[0060] In the device (this is explained in detail later.) which combined monostable FLCD with the TFT active matrix for the conventional TN liquid crystal (0.7 inches, for 103,000 pixel viewfinders), amelioration of an orientation treatment process and improvement in gap precision attained the uniform liquid crystal stacking tendency of FLC considered to be difficult on level difference structure until now.
[0061] As a driving method, color display of the video rate which has the above-mentioned large angle of visibility was realized by applying the Rhine reversal or field reversal like TN liquid crystal. Also in high-speed migration of the photographic subject in a video camera currently picturized, tailing actually checked few [very] things.
[0062] Electric field as drive mode The normally black mode which serves as dark level when it is off is desirable the point of maintaining electrical neutrality in monostable FLC, and in respect of high contrast.
[0063] Next, a display device is produced combining TFT which is an active-matrix component

about monostable FLC based on above-mentioned this invention, and the example which measured the property is explained to a detail.

[0064] Example 1 (production of active-matrix drive mold monostable FLC display device I)
As a component of an active matrix, TFT (Thin Film Transistor: thin film transistor) can be used, for example. Here, R, G, and the TFT component corresponding to B color filter were used.

[0065] The configuration of active-matrix drive mold monostable FLC display device with color filter I is shown in drawing 1 . the N-methyl-2-pyrrolidone solution of U[by Ube Industries, Ltd.]-varnish is applied to TFT6 side on glass substrate 1a by the spin cast method — it calcinates at 200 degree C — polyimide orientation film of 500 A 5a was formed, and rubbing orientation processing was carried out with the roller around which the cloth of an acetate system was wound further. Moreover, the common electrode 4 side formed black Matrix 2 of chromium, the color filter 3, and the transparent electrode (ITO) 4 on glass substrate 1b at this sequence, formed polyimide film 5b in the field of that transparent electrode like the above, and performed rubbing orientation processing.

[0066] Thus, the TFT side panel with the produced orientation film and the color filter side panel were constructed so that the orientation processing direction might serve as anti-parallel by the opposed face, and the glass bead (true glomus: diameter 0.8 - 1.5 mum (catalyst formation industrial company make)) according to the purpose gap length was used as the spacer 7. inside of the sealing compound 8 (adhesives of UV hardening mold (photograph lek: the Sekisui Chemistry company make)) on which a spacer 7 pastes up a perimeter about 0.3wt% — by making it distribute, the gap between substrates was controlled, and the injected hole of liquid crystal was secured and the perimeter of a cel was pasted up by the above-mentioned sealing compound.

[0067] Then, the monostable ferroelectric liquid crystal constituent 9 was poured in under reduced pressure in the condition which shows the fluidity of isotropic phase temperature or chiral nematic phase temperature. After cooling slowly and removing the liquid crystal on the glass substrate of the perimeter of an injected hole after liquid crystal impregnation, it closed with UV hardening mold adhesives, and the monostable ferroelectric liquid crystal component was produced. The ferroelectric liquid crystal 9 used here used for the above-mentioned table 1, FLC3 (micrometers [of pitch length / 10], spontaneous polarization 16 nC/cm2) or the constituent 2 (micrometers [of chiral component 2wt% and pitch length / 21.2], spontaneous polarization 2.5 nC/cm2) by Japanese Patent Application No. No. 25131 [three to] by these people, for example, phenyl pyrimidine-liquid-crystal FLC, of a publication.

[0068] With the orientation processing direction, it was parallel, or intersected perpendicularly with each above-mentioned panel, polarizing plates 10a and 10b were formed, and it has arranged to device both sides. The arranged polarizing plate 10 was made to intersect perpendicularly mutually. Furthermore, monostable ferroelectric liquid crystal display device I was completed by arranging a back light 11 to the TFT component side of this panel.

[0069] Example 2 (drive of active-matrix drive mold monostable FLC display device I)
The layout of the component configuration of the active matrix for color filters is shown in drawing 2 . The NTSC signal was changed into each luminance signal of R, G, and B by the decoder, and H for driving TFT to coincidence and the clock pulse for V shift registers were generated from the pulse driver. Each terminal signal in this TFT panel is collectively shown in the following table 3.

[0070] On the occasion of the drive of this display device I, the predetermined signal shown in the following table 3 from each terminal is alternatively inputted into TFT through each gate transistor TR from H shift register, and a switching electrical potential difference is impressed to monostable FLC9 by TFT according to the gate control signal from V shift register (a capacitor for Cs to accumulate 1 frame time of signal charges and COM are the component sections which supply common potential).

[0071]

表３Ａ（ＴＦＴパネルの端子信号）

端子番号	端子記号	電　圧	端　子　説　明
1	GREEN	10.5V(DC)	ビデオ信号（G）入力
2	RED	10.5V(DC)	ビデオ信号（R）入力
3	BLUE	10.5V(DC)	ビデオ信号（B）入力
4	HVSS	０V	Ｈドライバ用ＧＮＤ端子
5	TP1	OPEN	テスト端子
6*	HCK1	定格クロック	Ｈシフトレジスタ駆動用クロック入力端子
7*	HCK2	定格クロック	Ｈシフトレジスタ駆動用クロック入力端子
8	HST	定格クロック	Ｈシフトレジスタ駆動用スタートパルス入力端子

[0072]

表３Ｂ（ＴＦＴパネルの端子信号）

端子番号	端子記号	電　圧	端　子　説　明
9	HVDD	12V(DC)	Ｈドライバ用電源入力端子
10*	VCK2	定格クロック又は12V(DC)	Ｖシフトレジスタ駆動用クロック入力端子
11*	VCK1		Ｖシフトレジスタ駆動用クロック入力端子
12	VVSS	０V	Ｖドライバ用ＧＮＤ端子
13	VST	12V(DC)	Ｖシフトレジスタ駆動用スタートパルス入力端子
14	VVDD	13.5V(DC)	Ｖドライバ用電源入力端子
15	TP2	OPEN	テスト端子
16	VCOM	６V(DC)	パネルの対向電圧入力端子

* Phase of H and V 180 degrees and a frequency are arbitration.
DC of +4.5 V is impressed to liquid crystal by this electrical-potential-difference impression.

[0073] When image display was carried out with the field frequency of 60Hz, the display which has the large angle of visibility of **50 degrees or more was realizable at 200 or less microseconds and a high speed with this example.
[0074] Example 3 (production of the active-matrix drive mold monostable FLC display device II without a color filter)
As an active-matrix component, TFT (Thin Film Transistor: thin film transistor) can be used, for example. Here, the TFT component for monochrome was used.
[0075] The configuration of the active-matrix drive mold monostable FLC display device II of color filter loess is shown in drawing 3 . the N-methyl-2-pyrrolidone solution of U[by Ube Industries, Ltd.]-varnish is applied to the TFT6 side of glass substrate 1a by the spin cast method — it calcinates at 200 degree C — polyimide orientation film of 500 A 5a was formed, and rubbing orientation processing was carried out with the roller around which the cloth of an acetate system was wound further. Moreover, the common electrode 4 side formed black Matrix 2 of chromium, and a transparent electrode (ITO) 4 on glass substrate 1b at this sequence, formed polyimide film 5b in that transparent electrode side 4 similarly, and performed rubbing orientation processing.
[0076] Thus, the TFT side panel with the produced orientation film and the color filter side panel were constructed so that the orientation processing direction might serve as anti-parallel by the opposed face, and the glass bead (true glomus: diameter 0.8 - 1.5 mum (catalyst formation industrial company make)) according to the purpose gap length was used as the spacer 7. inside of the sealing compound 8 (adhesives of UV hardening mold (photograph lek: the Sekisui Chemistry company make)) on which a spacer 7 pastes up a perimeter about 0.3wt% — by making it distribute, the gap between substrates was controlled, and the injected hole of liquid crystal was secured and the perimeter of a cel was pasted up by the above-mentioned sealing compound.
[0077] Then, the monostable ferroelectric liquid crystal constituent 9 was poured in under reduced pressure in the condition which shows the fluidity of isotropic phase temperature or chiral nematic phase temperature. After cooling slowly and removing the liquid crystal on the glass substrate of the perimeter of an injected hole after liquid crystal impregnation, it closed with UV hardening mold adhesives, and the monostable ferroelectric liquid crystal component was produced. The ferroelectric liquid crystal 9 used here used the same constituent as Example 1.
[0078] With the orientation processing direction, it was parallel, or intersected perpendicularly with each above-mentioned panel, polarizing plates 10a and 10b were formed, and it has arranged to device both sides. The arranged polarizing plate 10 was made to intersect perpendicularly mutually. Furthermore, the monostable ferroelectric liquid crystal display device II of color filter loess was completed by arranging a back light 11 to the TFT component side of this panel (however, although a color filter is prepared apart from an FLC component, refer to drawing 12 of :postscript which carried out the illustration abbreviation here for it).
[0079] Example 4 (drive of the active-matrix drive mold monostable FLC display device II)
The layout of the component configuration of the active matrix for color filter loess (monochrome) is shown in drawing 4 . The NTSC signal was changed into R, G, and B signal by the decoder, and H for driving TFT to coincidence and the clock pulse for V shift registers were generated from the pulse driver. Although each terminal signal in this TFT panel was shown in the above-mentioned table 3, in this example, each luminance signal of each R, and G and B was inputted from the common terminal of No. 3.
[0080] Also in this example, when image display was carried out with the field frequency of 60Hz, the display which has the large angle of visibility of **50 degrees or more was realizable with 200 or less microseconds and a high speed. And since each signal of R, G, and B can be inputted from a common terminal by color filter loess, as compared with TFT for color filters, the effective number of pixels can be increased 3 times, and high-resolution-izing is possible.
[0081] Example 5 (color order the production approach of the liquid crystal filter for degree change)
The configuration of a cel is as being shown in drawing 5 . That is, transparent electrodes 4a and

4b (ITO ofohms [100] / **) were attached on transparence glass substrate 1a and 1b, and the method vacuum evaporationo film 5a and 5b of slanting of SiO was further formed as liquid crystal orientation film on it. As the formation approach of this method vacuum evaporationo film of SiO slanting, in the vacuum evaporation system, the substrate was arranged on the vertical from the source of SiO vacuum evaporationo, and the angle which the line of a vertical and a substrate normal make was installed as 85 degrees. It is substrate temperature about SiO. The vacuum deposition back, and 300 degree C and baking of 1 hour were performed at 170 degrees C.
[0082] Thus, the produced substrate with the orientation film was constructed so that the orientation processing direction might serve as anti-parallel by the opposed face, and the glass bead (true glomus: diameter 0.8 - 3.0 mum (catalyst formation industrial company make)) according to the purpose gap length was used as the spacer 7. inside of the sealing compound 8 (adhesives of UV hardening mold (photograph lek: the Sekisui Chemistry company make)) on which a spacer 7 pastes up a perimeter with the magnitude of a transparence substrate in the case of a small area about 0.3wt% -- the gap between substrates was controlled by making it distribute. Furthermore, when substrate area is large, it is mean density on a substrate about the above-mentioned truth glomus. 100 piece/mm2 After sprinkling, the gap was taken, the injected hole of liquid crystal was secured and the perimeter of a cel was pasted up by the above-mentioned sealing compound.
[0083] Then, the ferroelectric liquid crystal 9 (for example, CS[by Chisso / Corp. / Corp.]-1014) was poured in under reduced pressure in the condition which shows the fluidity of isotropic phase temperature or chiral nematic phase temperature. After cooling slowly and removing the liquid crystal on the glass substrate of the perimeter of an injected hole after liquid crystal impregnation, it closed with the adhesives of an epoxy system and the ferroelectric liquid crystal component was produced.
[0084] Although the Chisso [Corp.] Corp. make, the Merck [Co.]& Co., Inc. make, the product made from BDH, other well-known ferroelectric liquid crystal compounds, or a constituent with un-chiral liquid crystal is also possible for the ferroelectric liquid crystal to be used, the limit does not exist, and does not need a limit of the phase sequence, either, but the thing which is the need is taking a chiral smectic liquid crystal phase in operating temperature limits. Furthermore, if the switching speed except chiral smectic liquid crystal is high-speed, the smectic A phase which shows antiferroelectricity liquid crystal (AFLC) and an electroclinic effect is also applicable, for example.
[0085] The electro-optics property of the liquid crystal filter for a color sequential change by this example is as being shown in the following table 4.
[0086]
[Table 1]

表4（ＦＬＣ素子の電気光学特性）

ＦＬＣサンプル	ギャップ (μm)	レタデーション (nm)	見かけのコーン角 (deg)	方形波			パルス駆動			
				印加電圧	応答時間		印加電圧	パルス幅	応答時間	
					10-90%T	90-10%T			10-90%T	90-10%T
CS-1014	2.10	263.7	46.5	30Hz, ±15V	118 μs	100 μs	±20V	425 μs	61μs	56μs
							±30V	254 μs	40μs	36μs

[0087] According to this, it turns out that this liquid crystal filter (FLC liquid crystal device) shows the phase contrast of the abbreviation one half of use optical wavelength, and it has the spec. which can rotate the plane of polarization of incident light about 90 degrees.
[0088] Example 6 (color order drive wave of the liquid crystal filter for degree change)
As a method of driving the ferroelectric liquid crystal component of Example 5, the method of driving the conventional general FLC is applicable. An example of a drive wave which changes a switch condition to drawing 6 - drawing 9 once within one frame is shown.
[0089] Drawing 6 is a square wave drive. It is the approach of maintaining electrical neutrality conditions by one frame, and although the time amount to which DC electrical potential

difference is impressed compared with the pulse drive is long, when the insulation of a component is high, it is the reliable driving method. It can be used for AFLC besides FLC, and electroclinic effect mold smectic A.
[0090] Drawing 7 is the pulse drive with a reset pulse, it is the approach of adding a reset pulse and maintaining the electrical neutrality conditions in the field just before writing, and a prolonged dc component is hard to be impressed to liquid crystal.
[0091] Drawing 8 is the pulse drive without a reset pulse, and is the approach of maintaining the electrical neutrality conditions within one frame.
[0092] Drawing 9 is the pulse drive without a reset pulse, and is the approach a liquid crystal ingredient system with few memory effects can also hold a switch condition, and maintains the electrical neutrality conditions within one frame at coincidence by applied-voltage maintenance after pulse impression. It can be used also for AFLC besides FLC.
[0093] The switching characteristic by the above-mentioned drive wave was shown in the above-mentioned table 4. It starts (10-90%T), and falling (90-10%T) all shows the high-speed response of microsecond order, and sufficient response in 1 field is guaranteed.
[0094] Example 7 (color order configuration of a drive [degree] mold monostable FLC display device)
By combining the FLC component (switching device) and color polarizing plate (color filter) of Example 5 (or example 3), a switchable component is [the color of the transmitted light] realizable for R, G, and B. The configuration of a color sequential drive monostable FLC display device is shown in drawing 10.
[0095] That is, FLC component 12a (FLC1) which can rotate 90 degrees of plane of polarization at high speed in the front face of polarizing plate 10B (P1) of the monochrome type active-matrix drive mold monostable FLC display device of drawing 3 produced in Example 3, the color polarizing plate 13 (P2), FLC component 12b (FLC2), and the color polarizing plate 14 (P3) have been arranged in this order. The direction of the switch condition 1 of the abnormality optical axis of FLC1 and FLC2 has been arranged to a rectangular cross or parallel to the light transmission easy shaft of polarizing plate 10b (P1), and B light transmission easy shaft of the color polarizing plate P2 and R light transmission easy shaft of the color polarizing plate P3 have been further arranged in parallel to the light transmission easy shaft of a polarizing plate P1.
[0096] In the state of [2] the switch condition 1 and a switch, about 45 degrees of abnormality opticals axis incline, and it is the RETADESHON. By being referred to as 270nm For example, in order to carry out incidence of R and G which passed along the polarizing plate P1, and the B light in parallel with B light transmission easy shaft of the color polarizing plate P2 without receiving rotatory polarization when the switch condition of FLC1 is 15 (switch condition 1), it becomes only B light to penetrate the color polarizing plate P2.
[0097] If the switch condition of FLC2 is 15 at this time, in order to carry out incidence of the B light similarly in parallel with R light transmission easy shaft of the color polarizing plate P3, without receiving rotatory polarization, B light cannot be penetrated but serves as black. That is, black is always realizable irrespective of the gradation in a monostable FLC component in this case.
[0098] On the other hand, when the switch condition of FLC1 of R and G which passed along the polarizing plate P1, and B light is 16 (switch condition 2), in order for 90 degrees of plane of polarization to rotate and to carry out incidence in parallel with R of the color polarizing plate P2, and G light transmission easy shaft, it becomes only R and G light to penetrate the color polarizing plate P2.
[0099] If the switch condition of FLC2 is 15 at this time, in order to carry out incidence of R and the G light in parallel with G of the color polarizing plate P3, and B light transmission easy shaft, without receiving rotatory polarization, R light cannot be penetrated but penetrates only G. That is, the green display according to the gradation in a monostable FLC component is realizable in this case.
[0100] Moreover, if the switch condition of FLC2 is 16 at this time, since R and 90 degrees of G light plane of polarization will rotate and it will carry out incidence similarly in parallel with R light transmission easy shaft of the color polarizing plate P3, G light cannot be penetrated but

penetrates only R. That is, a display of the red according to the gradation in a monostable FLC component is realizable in this case.
[0101] The switch condition of FLC1 and FLC2 and the class of transmitted light were summarized into the following table 5.
[0102]
表５（ＦＬＣ１とＦＬＣ２のスイッチ状態と透過光の種類）

ＦＬＣ１	ＦＬＣ２	表示色	階調性
スイッチ状態１	スイッチ状態１	黒	な し
スイッチ状態１	スイッチ状態２ (90° 回転)	青	あ り
スイッチ状態２ (90° 回転)	スイッチ状態１	緑	あ り
スイッチ状態２ (90° 回転)	スイッチ状態２ (90° 回転)	赤	あ り

[0103] Thus, the change of a color was possible by the combination of the switch condition of the FLC components FLC1 and FLC2.
[0104] Example 8 (color order the driving [degree] method)
The method of driving the panel produced in Example 5 is explained. The configuration of the drive circuit of a color sequential drive mold monostable FLC display device is shown in drawing 11.
[0105] Although an input signal does not ask NTSC, Y/C, and an RGB code, it is made into R, G, and B signal by the decoder, and incorporates a part for the 1 field to a field memory 1. Before incorporating the next field, it transmits to the following buffer memory (field memory) 2. Furthermore, while having incorporated the next field, a full color display device is realizable by making it synchronize with a shift register driving pulse from a pulse driver, inputting R signal, G signal, and B signal into the signal terminal of No. 3 of a monostable FLC component from buffer memory 2, synchronizing coincidence with it and performing a color sequential change to it.
[0106] The timing table of a drive of this color sequential drive mold monostable FLC display device is shown in drawing 12. It is characteristic to have changed the color filter into the black condition and to have prevented degradation of image quality in the write-in process to monostable FLC, here, in the approach (for the square wave of drawing 6 to be used) of turning on R, G, and B once each in 1 field.
[0107] Usually, with NTSC system, the 1 field is 1/60. It is a second and each color includes the time of a write-in process and a hold. It must complete in 16.67 seconds. However, the display property will produce the so-called color breakup (each color of R, G, and B separates and is expressed as the edge of an image.) only by writing in R, G, and B once each in 1 field.
[0108] Therefore, color breakup is [R, G, and B] reducible 2 times (R/G/B/R/G/B) or by repeating 3 times (R/G/B/R/G/B/R/G/B). However, since, as for each switch condition, only the period for 1 / 540 seconds (1.85msec) is given at 1 / 360 seconds, and 3 times of cases, as for each switch condition, rapidity with the remarkable change rate of a color filter is required of 1 / 180 seconds, and 2 times of cases at 1 time of a case, as for each switch condition.
[0109] Then, when it was the above-mentioned FLC (ferroelectric liquid crystal) as a liquid crystal device, as it was shown in above-mentioned Table 4 and above-mentioned drawing 19, it is build up time. Since 0.1 or less msecs were attained, high-speed sufficient switching corresponding to the above-mentioned change rate was attained.

[0110] As mentioned above, although this invention was explained about the example, the example mentioned above can transform it further based on the technical thought of this invention.
[0111] for example, various the quality of the material of each component of a liquid crystal device, structure, configurations, the approaches including the class of liquid crystal of assembling, etc. can be boiled and changed. As a display, if at least one side of the substrate (for example, above-mentioned 1a, 1b) is optically transparent, it is good.
[0112] In addition, although the example mentioned above explained the suitable liquid crystal device for a display device, it is desirable at the point that gradation nature (halftone) is realizable in especially a display device. However, this invention can apply not only a display device but a liquid crystal device to the display screen of a filter, or a shutter and OA equipment, a screen, the phase control component for wobbling, etc.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the outline sectional view of the liquid crystal display device based on this invention.
[Drawing 2] It is the layout pattern of the active matrix for this drive.
[Drawing 3] It is the outline sectional view of other liquid crystal display devices based on this invention.
[Drawing 4] It is the layout pattern of the active matrix for this drive.
[Drawing 5] It is the outline sectional view of a liquid crystal cell usable to this invention.
[Drawing 6] It is the drive wave form chart of a liquid crystal device.
[Drawing 7] They are other drive wave form charts of this liquid crystal device.
[Drawing 8] They are other drive wave form charts of this liquid crystal device.
[Drawing 9] It is the drive wave form chart of further others of this liquid crystal device.
[Drawing 10] It is the outline decomposition perspective view of a color sequential drive mold monostable FLC component device based on this invention.
[Drawing 11] It is the drive circuit diagram of this display device.
[Drawing 12] It is a timing table at the time of the drive of this display device.
[Drawing 13] It is the explanatory view showing the mode of an usable monostable FLC component in this invention.
[Drawing 14] It is the molecular structure Fig. of this monostable FLC.
[Drawing 15] It is the electro-optics property Fig. of this monostable FLC component.
[Drawing 16] It is the explanatory view of optical system used for the electro-optics characterization of this monostable FLC component.
[Drawing 17] It is the graph which shows the applied-voltage dependency of the tilt angle of this monostable FLC component.
[Drawing 18] It is the graph which shows the applied-voltage dependency of the permeability of this monostable FLC component.
[Drawing 19] It is the graph which shows the temperature and the applied-voltage dependency of build up time of this monostable FLC component.
[Drawing 20] It is the graph which shows the temperature dependence of the falling time amount of this monostable FLC component.
[Drawing 21] It is the graph which shows the angle-of-visibility dependency of the permeability of the conventional TN component.
[Drawing 22] It is the graph which shows the angle-of-visibility dependency of the permeability of an usable monostable FLC component to this invention.
[Drawing 23] It is the explanatory view showing the mode of the conventional bistability FLC component.
[Description of Notations]
1a, 1b ... Substrate
2 ... Black matrix
3 ... Color filter
4 ... Transparent electrode layer

5a, 5b ... Liquid crystal orientation film (liquid crystal orientation film control layer)
6 ... A transparent electrode and TFT
9, 12a, 12b, FLC ... A ferroelectric liquid crystal or component
10a, 10b ... Polarizing plate
11 ... Back light
13 14 ... Color polarizing plate
TFT ... Thin film transistor

[Translation done.]

* NOTICES *

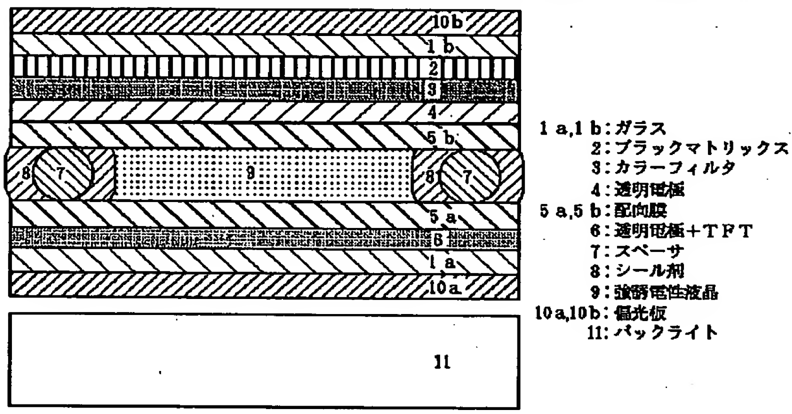
JPO and NCIPI are not responsible for any
damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

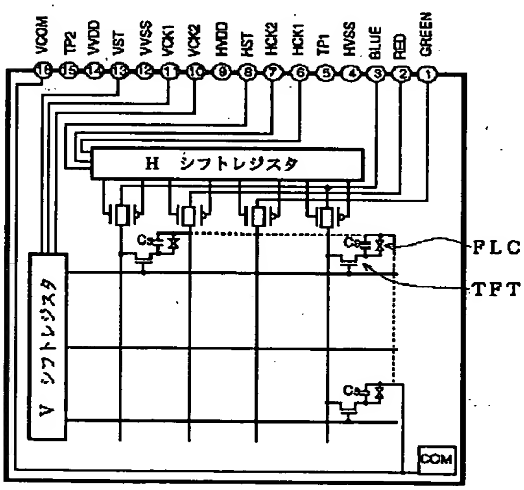
[Drawing 1]

カラーフィルタ付きアクティブマトリックス駆動型単安定ＦＬＣ表示デバイスの構成



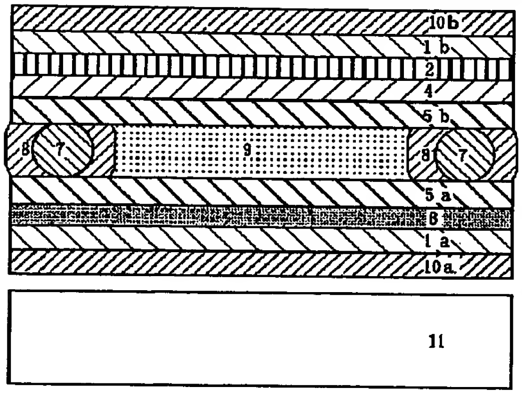
[Drawing 2]

カラーフィルタ用アクティブマトリックスの素子構成



[Drawing 3]

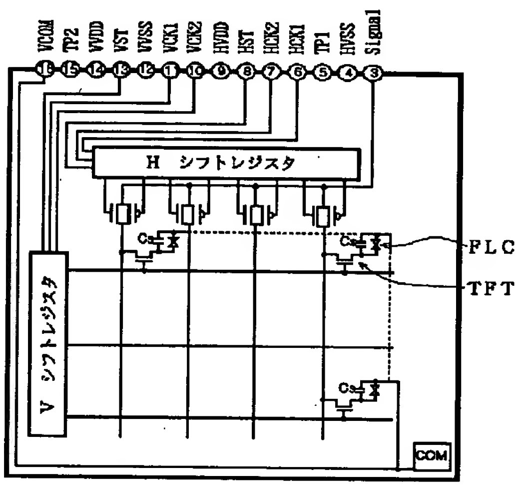
カラーフィルタレスのアクティブマトリックス駆動型単安定FLC表示デバイスの構成



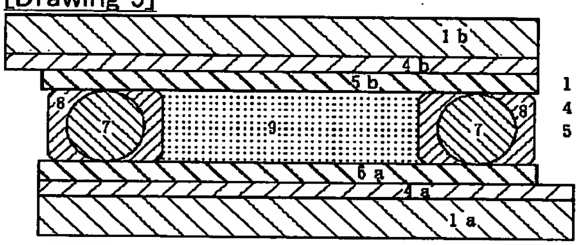
1a,1b：ガラス
2：ブラックマトリックス
4：透明電極
5a,5b：配向膜
6：透明電極＋TFT
7：スペーサ
8：シール剤
9：強誘電性液晶
10a,10b：偏光板
11：バックライト

[Drawing 4]

モノクロ用アクティブマトリックスの素子構成



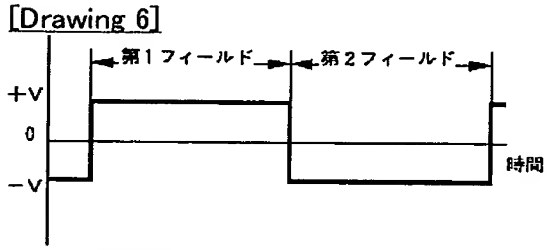
[Drawing 5]



1a,1b：ガラス
4a,4b：透明電極
5a,5b：配向膜
7：スペーサ
8：シール剤
9：強誘電性液晶

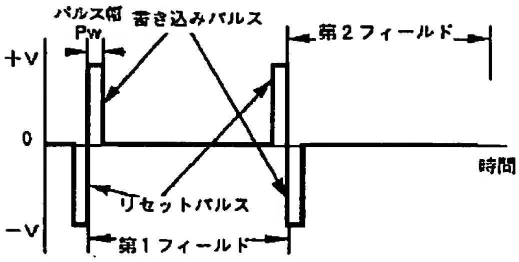
セルの構成

[Drawing 6]



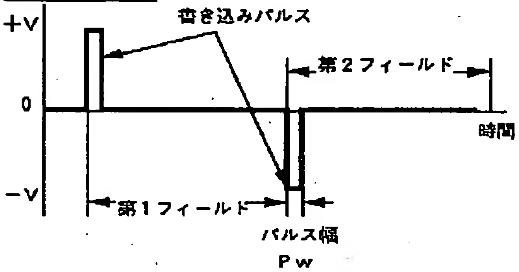
方形波駆動

[Drawing 7]



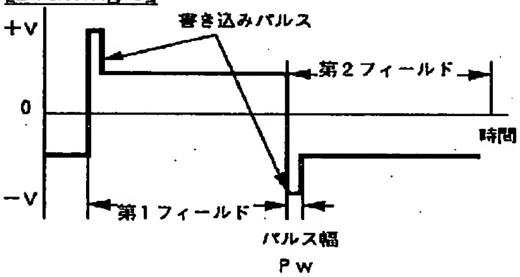
パルス駆動（リセットパルス付き）

[Drawing 8]



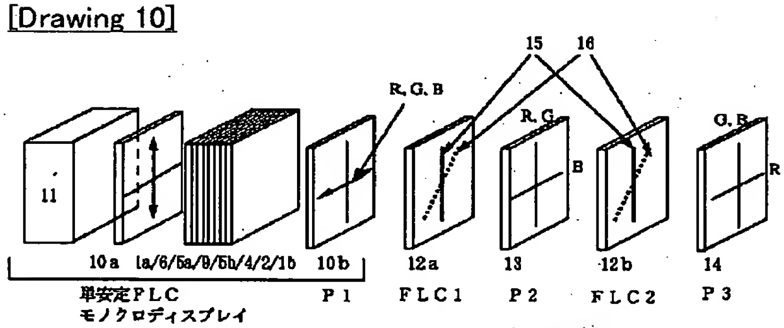
パルス駆動（リセットパルスなし）

[Drawing 9]



パルス駆動（リセットパルスなし、保持電圧印加）

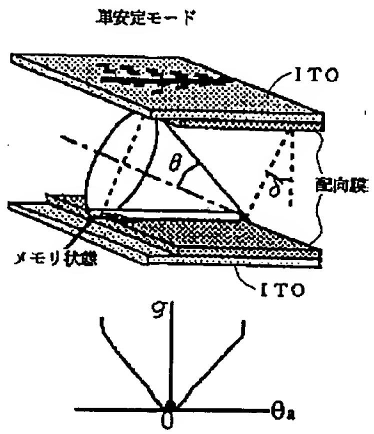
[Drawing 10]



10a, 10b：ニュートラル偏光板
11：バックライト
12a, 12b：FLC素子
13：カラー偏光板
14：カラー偏光板
15：液晶スイッチ状態1
16：液晶スイッチ状態2

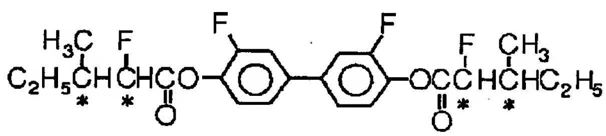
色順次駆動単安定FLC表示デバイスの構成

[Drawing 13]

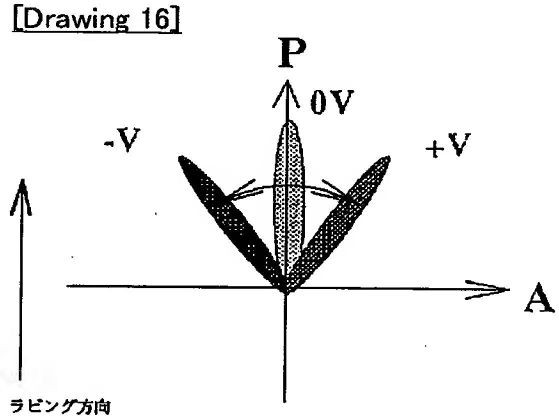


[Drawing 14]

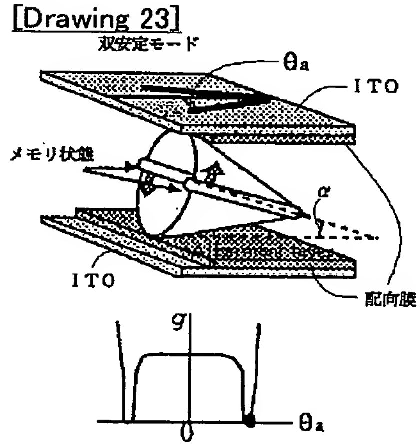
単安定ＦＬＣの分子構造



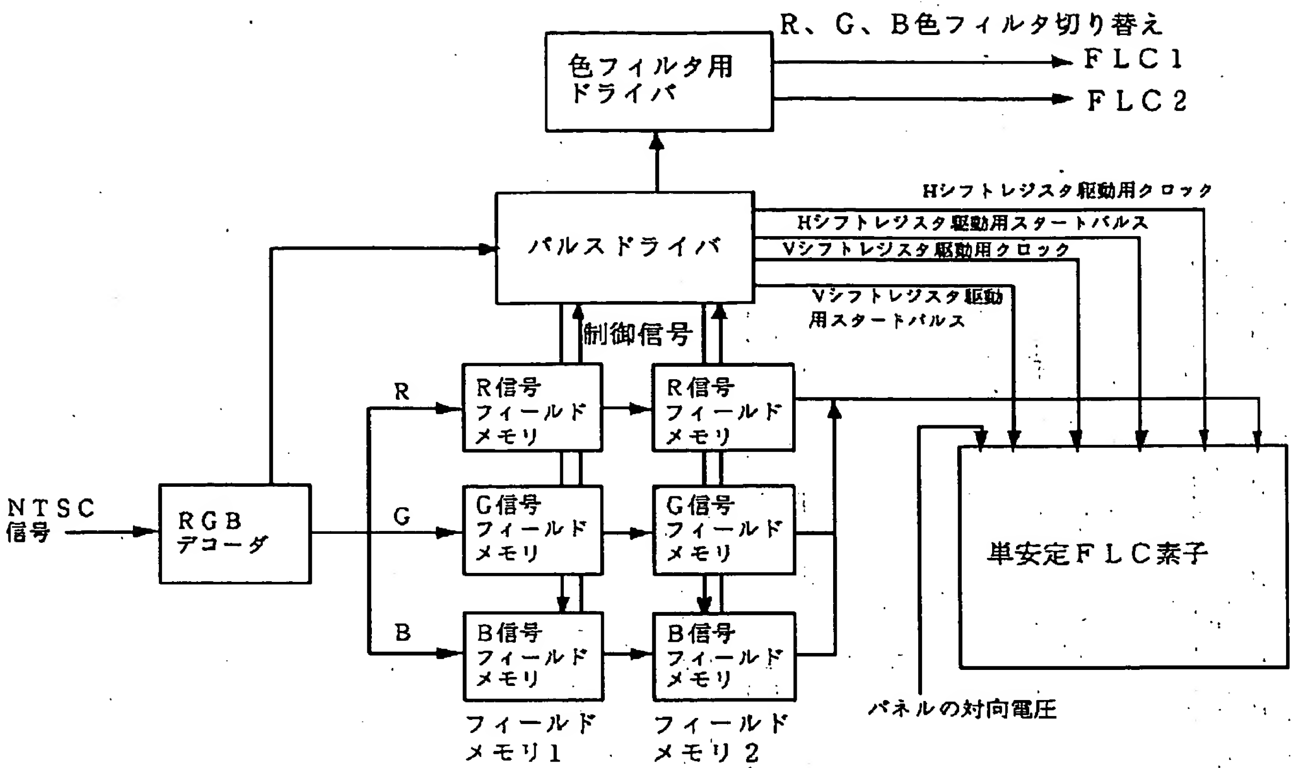
[Drawing 16]



[Drawing 23]

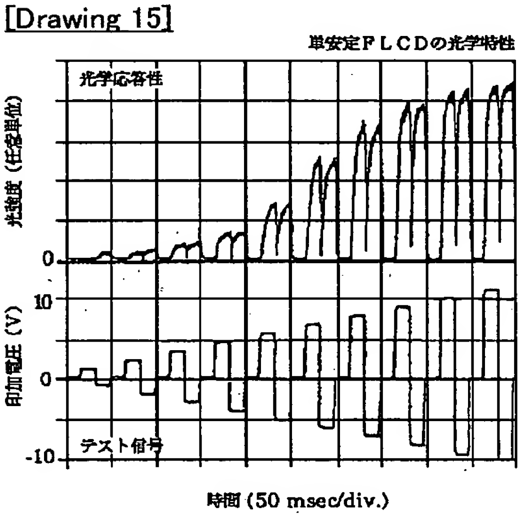


[Drawing 11]

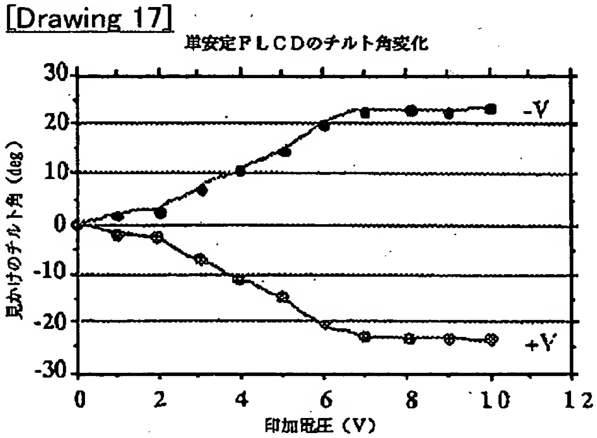


色順次駆動型単安定FLC表示デバイスの駆動回路

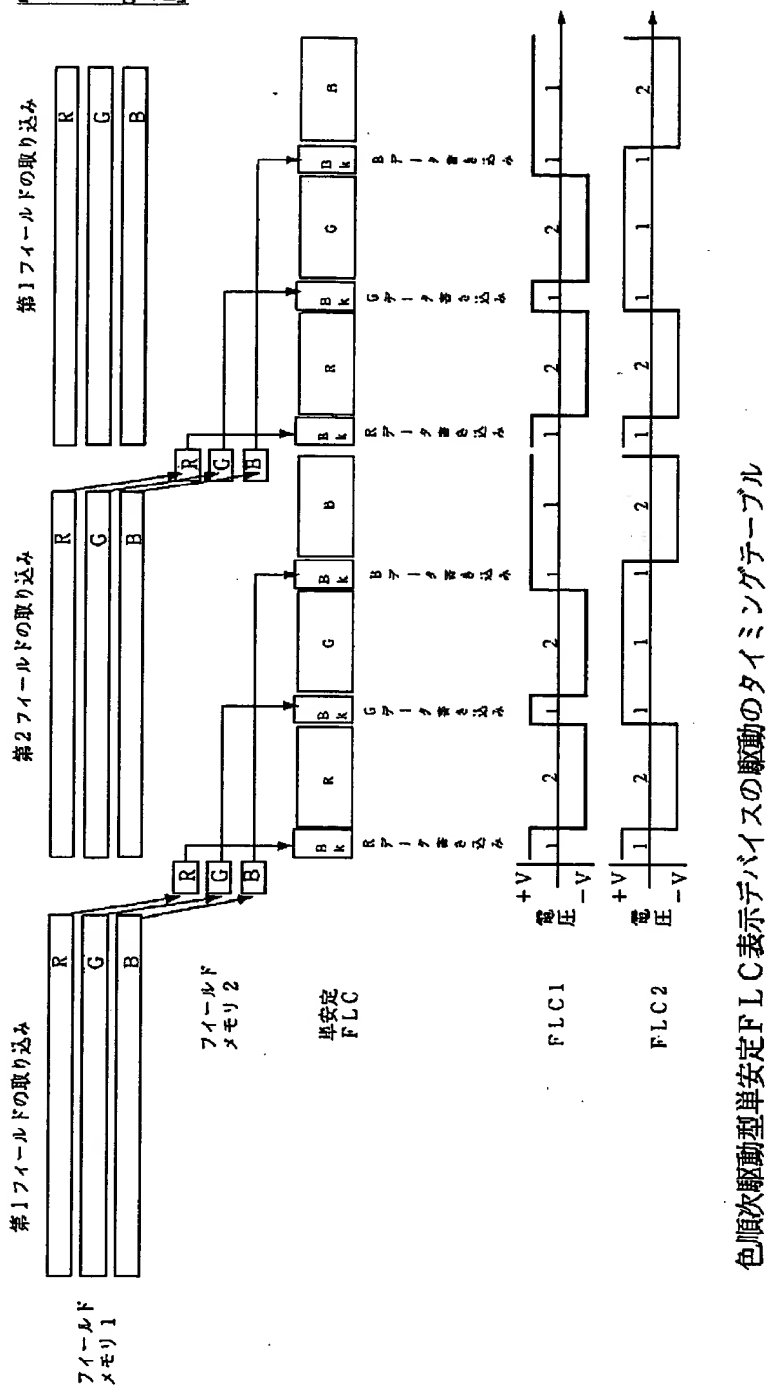
[Drawing 15]



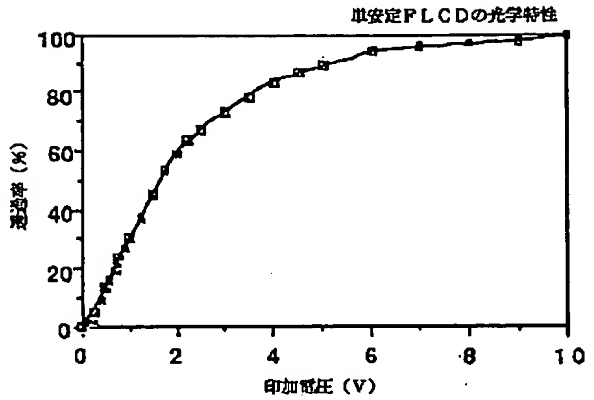
[Drawing 17]



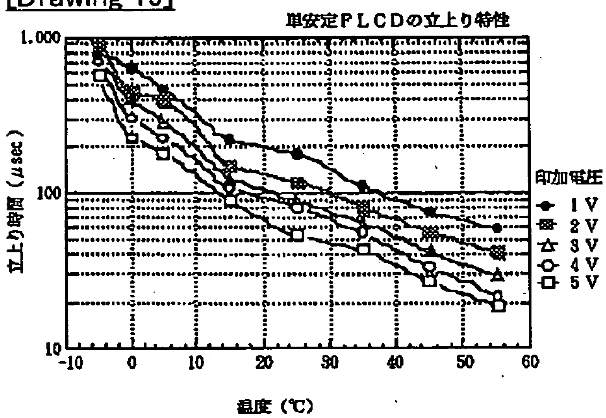
[Drawing 12]



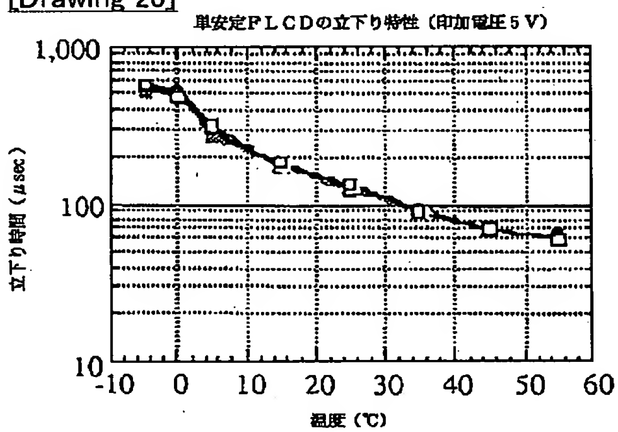
[Drawing 18]



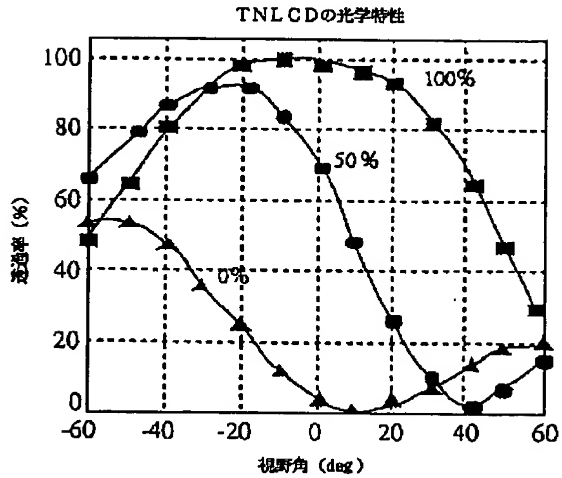
[Drawing 19]



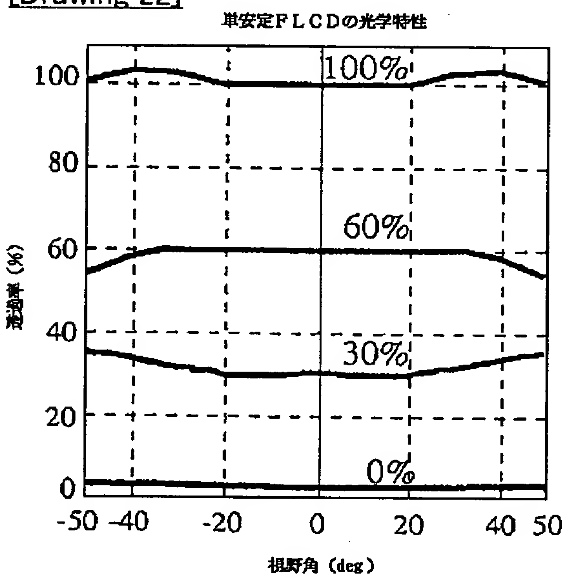
[Drawing 20]



[Drawing 21]



[Drawing 22]



[Translation done.]